R6000-5.7

COMMITTEE ON
POPULATION AND DEMOGRAPHY

Report No. 8

Trends in Fertility and Mortality in Turkey, 1935-1975

Frederic C. Shorter
Miroslav Macura

Panel on Turkey
Committee on Population and Demography
Assembly of Behavioral and Social Sciences
National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1982

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

Library of Congress Catalog Card Number 81-86661
International Standard Book Number 0-309-03239-3

Available from:

NATIONAL ACADEMY PRESS
2101 Constitution Ave., N.W.
Washington, D.C. 20418

Printed in the United States of America

PANEL ON TURKEY

NUSRET H. FIŞEK, Institute of Community Medicine,
Hacettepe University, Ankara, Turkey
SEVİNÇ KAVADARLI, Institute of Population Studies,
Hacettepe University, Ankara, Turkey
MIROSLAV MACURA, Economic Institute, Belgrade, Yugoslavia
FERHUNDE ÖZBAY, Research Institute of Social Sciences,
Ankara Academy of Economics and Commerce, Ankara,
Turkey
FREDERIC C. SHORTER, The Population Council, Cairo, Egypt
SAMİRA YENER, State Planning Organization, Ankara, Turkey

ROBERT J. LAPHAM, *Study Director*

COMMITTEE ON POPULATION AND DEMOGRAPHY

ANSLEY J. COALE (*Chair*), Office of Population Research, Princeton University
WILLIAM BRASS, Centre for Population Studies, London School of Hygiene and Tropical Medicine
LEE-JAY CHO, East-West Population Institute, East-West Center, Honolulu
RONALD FREEDMAN, Population Studies Center, University of Michigan
NATHAN KEYFITZ, Department of Sociology, Harvard University
LESLIE KISH, Institute for Social Research, University of Michigan
W. PARKER MAULDIN, Population Division, The Rockefeller Foundation, New York
JANE MENKEN, Office of Population Research, Princeton University
SAMUEL PRESTON, Population Studies Center, University of Pennsylvania
WILLIAM SELTZER, Statistical Office, United Nations
CONRAD TAEUBER, Kennedy Institute, Center for Population Research, Georgetown University
ETIENNE VAN DE WALLE, Population Studies Center, University of Pennsylvania

ROBERT J. LAPHAM, *Study Director*

NOTE: Members of the Committee and its panels and working groups participated in this project in their individual capacities; the listing of their organizational affiliation is for identification purposes only, and the views and designations used in this report are not necessarily those of the organizations mentioned.

Contents

LIST OF TABLES vii

LIST OF FIGURES ix

PREFACE xi

SUMMARY 1

Fertility, 2
Mortality, 6
Population Growth, 8

1 INTRODUCTION 12

Background, 12
Data Sources, 13

2 FERTILITY 20

National Crude Birth Rates, 1935-75, 20
National Total Fertility Rates, 1935-75, 29
National Trends in Marital Fertility, 1935-75, 36
Fertility by Divisions of the Population, 1945-68, 42

3 MORTALITY 56

National Infant and Early Childhood Mortality, 1945-75, 56

Infant and Early Childhood Mortality by Divisions, 1945-67, 68
National Mortality Above Age 5, 1935-75, 81
National General Mortality, 1935-75, 91

4 NATIONAL POPULATION GROWTH, 1935-75 96

Components of Population Increase, 96
Sum of Components, 99

APPENDIXES 101

A Estimation of Fertility by Multiple Reverse Projection, 101

B Estimation of Trends in Infant and Early Childhood Mortality from Birth-Survival Histories, 111

C Adjustment of the National Censuses for Age Misreporting, 117

D International Migration, 124

E Population of Six Divisions by Age and Sex, 1945-70, 129

GLOSSARY 137

REFERENCES 147

List of Tables

1 Population of Turkey by Age and Sex as Reported in the Censuses, 1935 to 1975 14
2 National Crude Birth Rates, 1935-75, Estimated by Multiple Reverse Projection 24
3 Summary of National Crude Birth Rate Estimates, 1935-75 28
4 Percentage National Diistribution by Age of Marital Fertility, 1963-73, Compared with a Schedule of Natural Fertility 30
5 National Proportions of Females Married by Age, from 1935-75 Censuses 31
6 National Proportions of Married Women Currently Using Some Method of Contraception by Age Group, Derived from National Sample Surveys in 1963, 1968, and 1973 33
7 National Fertility Indexes, 1935-75 37
8 National Number of Women Ever Married, per 1,000 Women by Cohorts, and Mean Age of First Marriage (SMAM), 1930-35 to 1970-75 39
9 Population Size and Growth by Six Divisions, 1945-70 44
10 Estimation of Crude Birth Rate for Istanbul and Izmir, 1945-68 46
11 Estimated Crude Birth Rates by Six Divisions, 1945-68 46
12 Proportions Married Females by Divisions of the Population, 1945-68 and Standard Marital Fertility Schedule 48
13 Fertility and Marriage Indexes by Divisions, 1945-68 51
14 Components of Urban Population Growth, 1945-70 52
15 Births by Education of Mother, Standardized by Duration of Marriage, from the 1968 Hacettepe Survey 54
16 National Life Table, Based on One Year of Data Centered on February 1967 60
17 Age Patterns of Early Childhood Mortality in

	Turkish Life Tables and in the "East" and "West" Families of Model Life Tables	63
18	National Infant Mortality Rate, 1945-70	64
19	Estimates of the National Infant Mortality Rate Based on Reports of Mothers at Different Ages, Four Sources	65
20	Estimates of Infant Mortality by Divisions, 1945-70	69
21	Infant Mortality Rates by Divisions from Birth-Survival Histories (BSH) Compared with Brass-Trussell Estimates from Various Sources, 1960, 1963, 1967	70
22	Adjustment of Urban Infant Mortality Rate for Transfer of Rural Communities to Urban Sector, 1945	78
23	Urban Infant Mortality Rates Adjusted for Reporting Error Due to Migration of Mothers and Transfers of Communities from Rural to Urban, 1945-67	79
24	Infant Mortality and Fertility Indexes by Province, Circa 1967 and 1960	84
25	Estimates of Mortality Above Age 5 by Forward Projection, 1935-75	89
26	Sex Differentials in Infant and Early Childhood Mortality Compared with Differential Predicted by the "East" Models	92
27	Expectation of Life at Birth, 1945-75	93
28	National Mortality Assumptions of the Multiple Reverse Projections, 1935-75	95
29	Rates of Population Change and Two Alternative Estimates of the Death Rate, 1935-75	97
A-1	Sample Reverse Projection from 1975	108
C-1	Proportions of "True" Population of Females in 1955 Transferred Upward or Downward from Five-Year Age Groups by Misreporting	118
C-2	Comparison of Demeny-Shorter (D-S) and P. Das Gupta (PDG) "Corrections" of Age Distributions for Misstatement of Age, Females, 1955 and 1960	119
C-3	Population by Age and Sex, Corrected for Age Misreporting, 1935-75	122
D-1	Demographic Effect of International Migration on National Population Size, 1935-75	126
D-2	Average Yearly International Migration for Intercensal Periods, 1935-75	127
D-3	Distribution of Net International Migration by Age, for Each Sex, 1960-75	128
E-1	Population of Six Divisions by Age and Sex as Reported in the Censuses, 1945-70	130

List of Figures

1 National Fertility Indexes, 1935-75 3
2 Crude Birth Rate, Total Fertility Rate, and Births by Rural-Urban Areas, 1945-68 5
3 Mortality Measures for Both Sexes Combined, 1935-75 7
4 Infant Mortality Rates by Rural-Urban Areas, 1945-67 9
5 Overall Rate and Components of National Population Increase, 1935-75 10
6 Estimates of Crude Birth Rate Based on Reported Age Distribution from One Census at End of Five-Year Period and Estimates Based on Distribution from all Available Censuses, 1935-75 25
7 Distribution by Age of Marital Fertility Under Natural and Controlled Conditions, Early 1960s and 1973 32
8 Estimates of Total Fertility Rate, 1935-75 34
9 National Mean Age of First Marriage for Cohorts and Current Index of Proportion Married (C_m), 1935-75 41
10 Urban-Rural and Regional Divisions of Turkey 43
11 Distribution of Marital Fertility by Age, from 1963 National Population Survey 49
12 Fertility Measures and Marriage Indexes, 1935-75 50
13 Total Fertility Rates by Province, 1960 53
14 Survivors from a Cohort of 100,000 Female Births (ℓ_x). Four Regional Models with same Values for ℓ_1 for Demographic Survey Estimates, 1966-67 62
15 Early Childhood Mortality Expressed in Terms of Infant Mortality Rate, 1945-75 66

16 Comparison of Infant Mortality Estimates from Birth-Survival Histories with Independent Brass-Trussell Estimates by Rural-Urban Divisions 71
17 Comparison of Infant Mortality Estimates from Birth-Survival Histories with Independent Brass-Trussell Estimates by Regions within Rural and Urban Divisions 72
18 Infant Mortality Rates by Divisions, 1945-67 80
19 Infant Mortality Rates by Provinces, 1967 82
20 Comparison of Mortality Above Age 5 in Turkish Life Tables with Four Families of Model Life Tables 87
21 Estimates of Mortality Above Age 5 by Forward Projection, 1935-75 90
22 Changes in the Deviant Child-Adult Pattern of Turkish Mortality, 1945-75 94
23 Alternative Estimates of the Crude Death Rate, 1935-75 98

A-1 Comparison of Estimates of CBR from Censuses Spaced Five and Ten Years Apart 110
C-1 Age Errors by Sex: Difference Between Enumerated and Corrected Population by Five-Year Age Groups 120
C-2 Population by Age and Sex Corrected for Age Misreporting, 1935 and 1975 121

Preface

The Committee on Population and Demography was established in April 1977 by the National Research Council in response to a request by the Agency for International Development (AID) of the U.S. Department of State. It was widely felt by those concerned that the time was ripe for a detailed review of levels and trends of fertility and mortality in the developing world. Although most people in the demographic community agree that mortality has declined in almost all developing countries during the last 30 years, there is uncertainty about more recent changes in mortality in some countries, about current levels of fertility, and about the existence and extent of recent changes in fertility.

In 1963, a Panel on Population Problems of the Committee on Science and Public Policy of the National Academy of Sciences published a report entitled The Growth of World Population. The appointment of that panel and the publication of its report were expressions of the concern then felt by scientists, as well as by other informed persons in many countries, about the implications of population trends. At that time, the most consequential trend was the pronounced and long-continued acceleration in the rate of increase of the population of the world, and especially of the population of the poorer countries. It was estimated in 1963 that the annual rate of increase of the global population had reached 2 percent, a rate that, if continued, would cause the total to double every 35 years. The disproportionate contribution of low-income areas to that acceleration was caused by rapid declines in mortality combined with high fertility that remained almost unchanged: the birth rate was nearly fixed or declined more modestly than the death rate.

Since the earlier report, however, the peak rate of growth in the world's population has apparently been passed. A dramatic decline in the birth rate in almost all the more developed countries has lowered their aggregate annual rate of increase to well below 1 percent, and the peak rate of increase has also apparently been passed in the less-developed parts of the world as a whole. A sharp decline in fertility in many low-income areas has more than offset the generally continued reduction in the death rate, although the rate of population increase remains high in almost all less-developed countries.

The causes of the reductions in fertility--whether they are the effect primarily of such general changes as lowered infant mortality, increasing education, urban rather than rural residence, and improving status of women or of such particular changes as spreading knowledge of and access to efficient methods of contraception or abortion--are strongly debated. There are also divergent views of the appropriate national and international policies on population in the face of these changing trends. The differences in opinion extend to different beliefs and assertions about what the population trends really are in many of the less-developed countries. Because births and deaths are recorded very incompletely in much of Africa, Asia, and Latin America, levels and trends of fertility and mortality must be estimated, and disagreement has arisen in some instances about the most reliable estimates of those levels and trends.

It was to examine these questions that the Committee on Population and Demography was established within the Assembly of Behavioral and Social Sciences of the National Research Council. It was funded initially for a period of three years by AID under Contract No. AID/pha-C-1161. The Committee has undertaken three major tasks:

1. To evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations;
2. To improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection);
3. To evaluate the factors determining the changes in birth rates in less-developed nations.

Given the magnitude of these tasks, the Committee decided to concentrate its initial efforts on the first two tasks; it initiated work on the third task in 1979.

The Committee approaches the first task through careful assessment, by internal and external comparison, and through analysis, by application of the most reliable methods known, of all the data sources available. Each of the country studies therefore consists of the application of a range of methods to a number of data sets. Best estimates of levels and recent trends are then developed on the grounds of their consistency and plausibility and the robustness of the individual methods from which they were derived.

The Committee's second task, refinement of methodology, is seen as a by-product of achieving the first. The application of particular methods to many different data sets from different countries and referring to different time periods will inevitably provide valuable information about the practical functioning of the methods themselves. Particular data sets might also require the development of new methodology or the refinement of existing techniques.

The Committee set three criteria for identifying countries to study in detail: that the country have a population large enough to be important in a world view; that there be some uncertainty about levels and recent trends of fertility or mortality; and that sufficient demographic data be available to warrant a detailed study. After a country has been selected for detailed study, the usual procedure is to set up a panel or working group of experts, both nationals of the country and others knowledgeable about the demography and demographic statistics of the country. The role of these panels and working groups, which generally include at least one Committee member, is to carry out the comparisons and analyses required. A small staff assists the Committee, panels, and working groups in their work.

As of late 1981, 168 population specialists, including 94 from developing countries, have been involved in the work of the Committee as members of panels or working groups. The Committee, the Assembly, and the National Research Council are grateful for the unpaid time and effort these experts have been willing to give.

Each country being studied has a different mix of data sources and different problems with data errors. Therefore, there is no standard pattern for all the reports. However, each report includes a summary of the main findings regarding estimates of fertility and mortality, a description of the data sources available, and a presentation of the analyses that were carried out, classified by type of data analyzed; detailed methodological descriptions are included where necessary in appendixes.

In some of the reports the estimates of fertility and mortality are presented as ranges. The use of a range is deliberate. It indicates that the panel and the Committee are confident that the range includes the true value, but have concluded that the evidence does not warrant selecting a single figure as best. The range conveys an important aspect (uncertainty) of the estimation. Ideally, in constructing an average for several populations in each of which estimation is presented as a range, an aggregate range would be calculated (as the population-weighted average of the constituents). The user who selects a single figure from the middle of the range does so at the risk of misleading simplification.

This report is number 8 in a series produced by the Committee. The report analyzes available data and provides estimates of the levels and recent trends of fertility and mortality in Turkey. It has been prepared by Frederic C. Shorter and Miroslav Macura with advice, consultation, and technical review provided by the other members of the Panel.

The Panel on Turkey was formed in 1978, with assistance from the Institute of Population Studies and the Institute of Community Medicine at Hacettepe University in Ankara, Turkey. The Institute of Population Studies arranged meeting space and provided other assistance to the Panel during the two Panel meetings held in 1978 and in 1980. Appreciation is extended to both Institutes and especially to Mithat Corun, director of the Institute of Population Studies at that time.

The Panel has functioned primarily in the planning and development of the project and in providing technical advice and critical review of the report. Review of draft tabulations and of the draft manuscript was carried out periodically between 1978 and 1980, both during and between Panel meetings. The Panel reviewed and approved the final manuscript.

The Turkey report is somewhat more detailed than other reports of the Committee because the Panel felt that a more detailed exposition would be useful for demographers and other persons concerned about population measurement in Turkey.

Special thanks and appreciation are due to Nusret H. Fişek, professor of community medicine and director of the Institute of Community Medicine, Hacettepe University. Dr. Fişek has been associated with population research and service delivery programs in Turkey for two decades, and he has provided an extensive background and insightful knowledge of population data and population phenomena in Turkey. Dr. Fişek was the first director of the Institute of Population Studies, a post he held for five years. In 1967 he organized the still-functioning Etimesgut Rural Health District, where integrated health services, including family planning, are provided to 80,000 people. The area is also used for epidemiologic, demographic, and health services research. Dr. Fişek was also instrumental in the establishment by the Institute of Community Medicine in 1975 of a field training and research program in the Cubuk Rural Health District (population 55,000). The Institute of Community Medicine is a collaborating center of the World Health Organization (WHO) in research and training on service delivery in the field of human reproduction.

This report takes into account and extends much prior analysis of population statistics for Turkey by the present authors and by other scholars whose work is referenced throughout this report. Most of this work has been done under the auspices of the Institute of Population Studies, the State Institute of Statistics, and the State Planning Organization of Turkey. Appreciation is expressed to the Institute of Population Studies for providing pregnancy history tabulations from the 1968 and 1973 fertility surveys.

The assistance of several individuals is acknowledged with warm thanks. Mahir Ulusoy and Osman Saracbasi of Hacettepe University produced the 1968 and 1973 pregnancy history tabulations. Robert Sendek of the Center for Policy Studies, Population Council, made useful tabulations from the 1963 Survey. Kadir Sumbuloglu, associate professor of biostatistics, Institute of Community Medicine, Hacettepe University, analyzed Turkey death registration data from province and district centers. Denise Batani, a graduate student in the Department of Statistics, University of Cairo, assisted with computations.

The Committee extends its sincere thanks for this study to all members of the Panel on Turkey, who managed amid busy schedules to assist with this project. Thanks are also extended to the staff of the Committee for their support, assistance, and advice. Katherine Miller edited the report and provided many ideas and suggestions for clarity and presentation. Eugenia Grohman, associate director for reports of the Assembly of Behavioral and Social Sciences, provided technical advice, and Elaine McGarraugh, editorial assistant, coordinated its production with the National Academy Press. Special thanks are due to Brenda Buchbinder, administrative assistant, for assisting with travel arrangements and other administrative tasks, and to Solveig Padilla, Benita Anderson, and Isis Bassili for typing the text and many tables. Carol Bradford Ward helped organize and proofread the tabulations and figures.

The Committee is also grateful to the individuals who have assisted in the review of early drafts of this report and to the members of the Assembly of Behavioral and Social Sciences and outside reviewers who reviewed the final draft. Their comments and suggestions have been most useful.

The Committee extends sincere appreciation to all of the individuals and institutions for their time and for the materials they provided for the preparation of this report.

ANSLEY J. COALE, *Chair*
Committee on Population and Demography

Summary

The data for this evaluation of fertility and mortality trends in Turkey cover a period of 40 years, from 1935 to 1975. The information is strongest and most detailed between 1945 and 1970, which includes the period when fertility commenced a sustained decline. This assessment examines both national trends and trends among divisions of the country. Since redistribution of the population by urbanization has been a major factor in the demography of the country, some information on these trends is also presented.

The Turkish transition from high birth and death rates was well advanced by the mid-1970s, but it was still far from reaching the low levels of European countries. During 1970-75, the most recent period for which reliable measures are available, the expectation of life at birth averaged 59 years, the infant mortality rate was approximately 126 deaths per thousand births, the crude birth rate was 34.9 per thousand population, and the total fertility rate was 5.05 children per woman.

After the work on the present report was completed, preliminary results of a national fertility survey conducted in 1978 became available. While these data may be subject to certain types of error, which would require adjustment when full details become available, they indicate a total fertility rate of 4.3 children per woman in 1977-78. An extrapolation of the accelerating downward trend from five years earlier yields a total fertility rate of 4.5 at the same date.

This summary presents an overview of the findings of the report, but reference must be made to the body of the report to obtain a more complete picture, including evaluation of the quality of estimates.

FERTILITY

The national fertility trend is measured by three major indexes: an index of fertility within marriage, the total fertility rate, and the crude birth rate. These three fertility indexes are related to each other through two intermediate indexes: an index of the proportions of women in the married state, and an index of age and sex structure for the population (see Figure 1).

Fertility within marriage is measured by the sum of age-specific marital fertility rates over the reproductive ages of women. The sum, which is denoted total marital fertility, began declining from a high plateau during the late 1940s or early 1950s, the exact year being impossible to specify with available data. The development of fertility control in some social groups within marriage probably predated the national decline of fertility because there were pre-existing differentials affecting at least small urbanized sections of the population. The sustained decline of marital fertility is accompanied by changes in the age pattern of marital fertility rates that clearly indicate increases in voluntary limitation of births. Indirect confirmation of the rise in birth planning is provided by data on contraceptive use by the married population over a limited segment of the trend period, from 1963 to 1973.

The total fertility rate, which measures the number of children women have on average given current age-specific rates, began its descent somewhat later than the decline of fertility within marriage. The reason for this delay was an increase in proportions of women exposed to childbearing up to the mid- or late 1950s. The marriage index, C_m, shows the proportions of women in a married state during the ages of potential childbearing increased. The upward trend in exposure was due to a downward trend in the age of marriage and to reductions in widowhood, the latter a consequence mainly of rising life expectancy for husbands. Only since the mid-1950s has the average age of first marriage for women begun to rise.

The overall decline of the total fertility rate is from a pre-decline level of 6.85 children to 5.05 children during 1970-75, amounting to 26 percent. Preliminary estimates from the 1978 national survey indicate that the decline is 37 percent when extended to a period of about 25 years. The rate of decline has been accelerating.

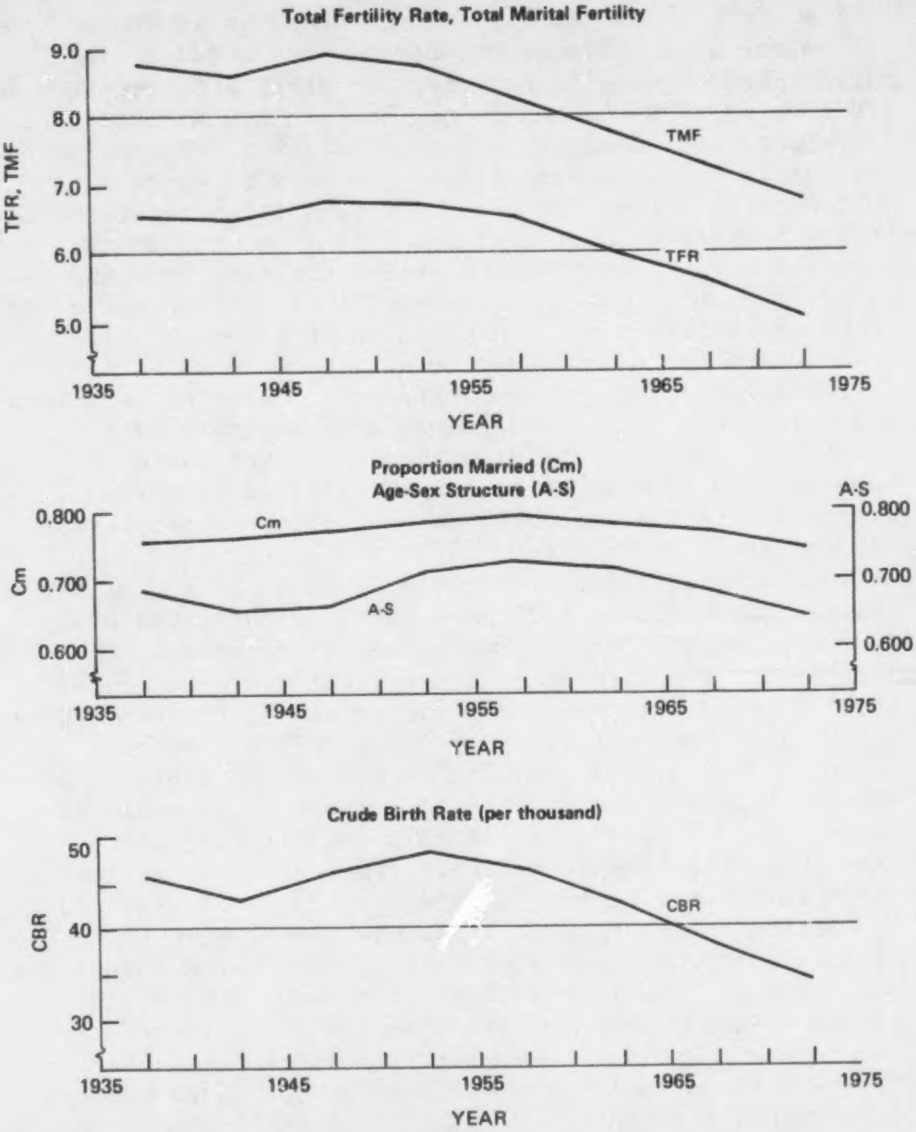


FIGURE 1 National Fertility Indexes, 1935-75: Turkey

The decline of total fertility up to 1970-75 can be factored into two elements: the decline of fertility within marriage and the reduction of marriage proportions. Eighty-one percent of the decline is due to reductions in marital fertility. Only 19 percent is due to marriage factors, specifically a rise in age of marriage, which came late, and some offsets due to declining widowhood.

The crude birth rate, which measures the growth of the population as a whole due to births, responded to the basic trend of total fertility, but it is affected in addition by slow changes in the age and sex structure of the population, denoted by A-S in Figure 1. Vacancies in the female age structure around the ages of highest childbearing during the late 1930s and 1940s are traceable to low numbers of births or low infant and childhood survival or some combination around the time that the Turkish Republic was established (1923). These vacancies meant fewer births and a depression in the crude birth rate during the period from roughly 1935 to 1950.

The exact trends of the different indexes of fertility prior to about 1950 are impossible to estimate with precision, due to certain weaknesses in the basic data. However, the general existence of a fertility plateau, with moderate fluctuations due to various causes before the decline, is confirmed.

The national trends of fertility from the end of the plateau period up to 1970 have been disaggregated by dividing the population into either three or six divisions. The three-part urban-rural division places the cities of Istanbul and Izmir at the most urban end of the scale. The rest of urban Turkey forms a second division. Ankara is included in the second division even though it is intermediate in size between Istanbul and Izmir. During the period of this study Ankara was a less urbanized city, demographically speaking, because its birth rates were higher and the proportion of the population having rural origins was higher than in Istanbul-Izmir. Rural communities, those with population less than 10,000, form a third division. Some of the analysis uses a six-part division involving three geographic regions of the rural and urban categories. Figure 2 shows fertility measures for the three major rural-urban divisions.

Based on the three-part urban-rural division, fertility in the mid-1940s was more than twice as high in rural Turkey as compared with Istanbul-Izmir, with the fertility of the "other urban" population intermediate between the two. Istanbul-Izmir was close to a replacement level of fertility in the late 1940s. Differentials of this type, which very likely had existed for some time, have narrowed somewhat since then. Rural fertility declined from the very beginning and there was a slight elevation of urban fertility, which then leveled off. However, the differential was still large in 1968, with

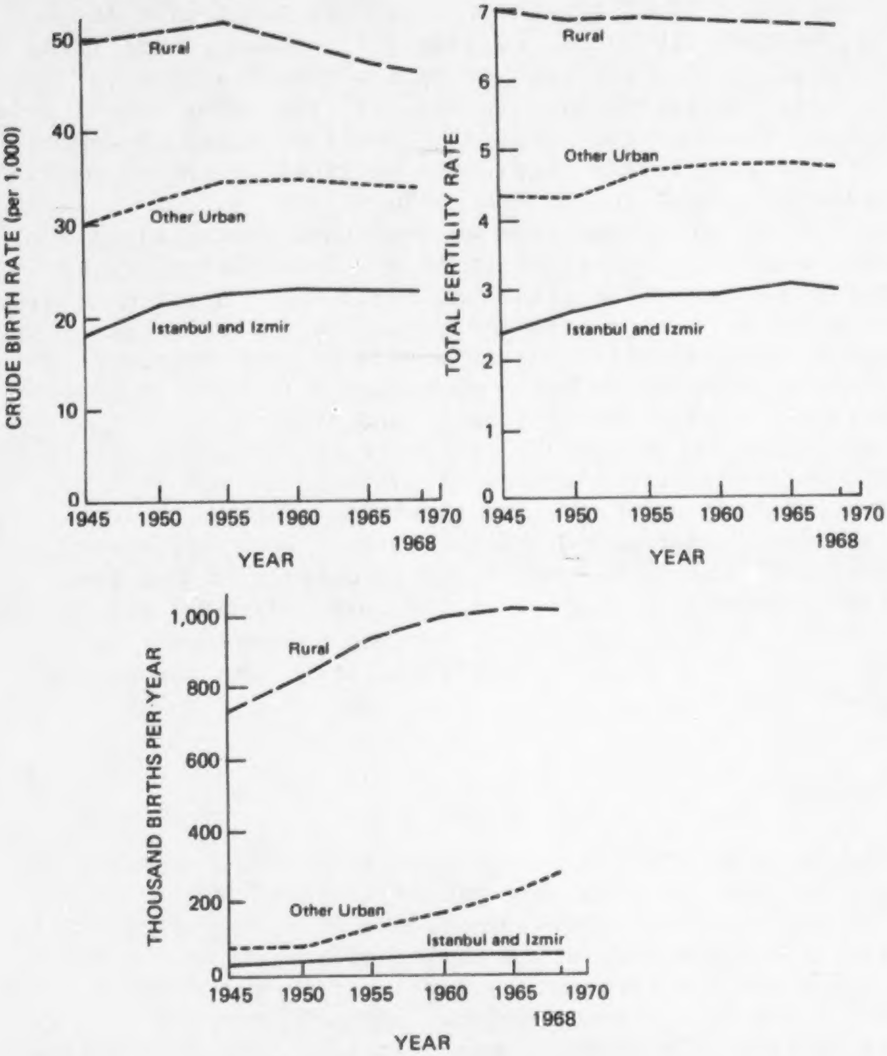


FIGURE 2 Crude Birth Rate, Total Fertility Rate, and Births by Rural-Urban Areas, 1945-68: Turkey

rural fertility at least double that of Istanbul-Izmir. Estimates by divisions for later dates are not possible with the available data.

The fertility of the national population could decline dramatically while the divisional levels changed little because the average fertility of families in the country as a whole is found by aggregating divisions of the population that changed in relative size. Prior to about

1950, the rate of growth of the urban population (due to all causes) was little different from that of the rural population, 2.5 percent per year compared with 2.1 percent, respectively. Thereafter, the urban growth rate jumped to a new and continuing level of around 6 percent per year, while the rural rate declined steadily, passing below 1 percent in the mid-1960s.

One of the connections between rural-urban migration and fertility is that the sons and daughters of rural parents move to the cities and have fewer children there than their parents' generation had in the villages. The cities have absorbed large numbers of people from rural areas without there being much change in average urban fertility, which was initially and still is much lower than rural fertility. Families of recent rural origin had more children than the original urban population, contributing to the slight elevation of overall urban fertility observed before the 1960s. However, downward fertility trends of various urban classes of population, including those of rural origin, are not ruled out by the observed overall elevation, because changes were taking place in the class composition of the urban population itself.

MORTALITY

The national decline in death rates probably reaches further back in time than can be captured by estimates for the 1935-75 period (see Figure 3). This at least is a good presumption, since the trend over those 40 years is downward, except for a rise in death rates during World War II. Although Turkey was not involved militarily, the material conditions of life deteriorated and there were a number of serious epidemics, both of which explain the reversal of trend.

For the late 1930s, various indices of mortality can be estimated only as orders of magnitude, due to the sparse nature of data for that period. The mortality indices can be estimated with greater confidence from the 1950s onward. On this understanding, life expectancy for both sexes combined appears to have risen from around 35 years in the 1950s to 59 years for the period 1970-75.

Infant and early childhood mortality is measured by the infant mortality index from the late 1940s up to the early 1970s. Estimates are reasonably strong from about 1960 onward and are acceptable indicators of national

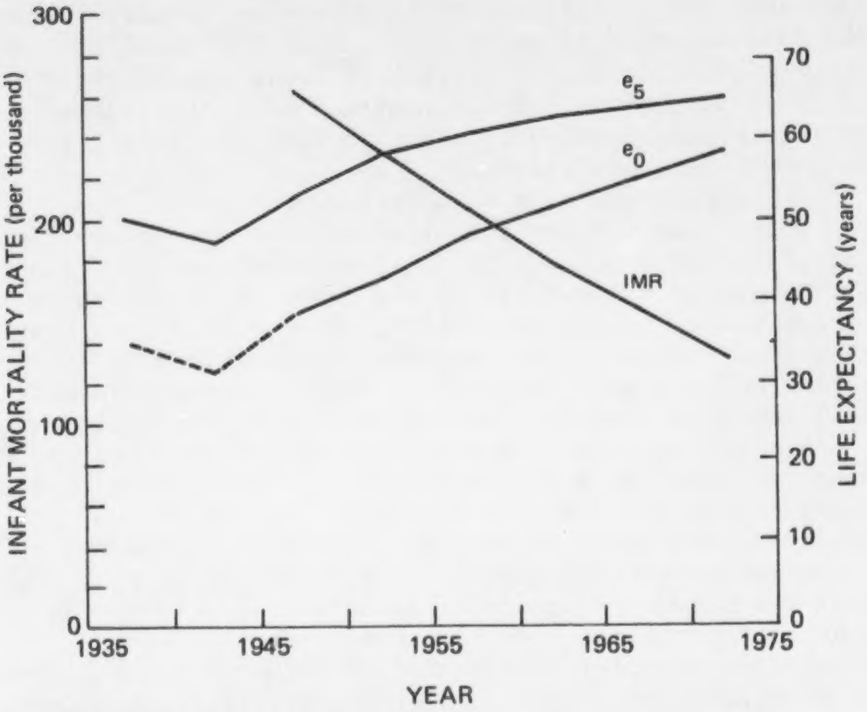


FIGURE 3 Mortality Measures for Both Sexes Combined, 1935-75: Turkey

Note: Dashed line shows that the estimate of e_0 was derived from e_5 by selecting split-model life tables to take the place of estimates for the IMR, which are unavailable for the earliest dates.

trends before that. Infant mortality declined from about 260 deaths per thousand births in the late 1940s to 126 per thousand in approximately 1973. The rate of decline does not seem to have changed much over the period, remaining near 3 percent per year.

In most populations that have as high an expectation of life after early childhood as in Turkey, the infant mortality rate would be around half the rate found in Turkey. The exact relationship varies considerably among countries, but there is no doubt that the infant mortality rate is exceptionally high in Turkey as compared historically and contemporaneously with other countries that have as low adult mortality as does Turkey. Whether the reduction of infant mortality has been held back by special disease factors, by unusual malnourishment, or by a general lag in infant and child care as compared with the health practices of adults, is an open question. The pattern of especially heavy infant mortality seems to apply to both sexes. Male infants have higher infant mortality than females by a margin similar to that found in many other populations.

The crude death rate is a less useful index of mortality than either life expectancy or the infant mortality rate, because it is affected markedly by age structure. Its level was on the order of 30 per thousand or a bit more in the late 1930s. It declined to a level of approximately 10 per thousand in the period 1970-75. As the proportion of population in the very lowest ages declines with falling birth rates, the persons subject to the highest age-specific death rates (infants) become less important as a source of deaths. Thus, part of the decline in the death rate is simply a reflection of declining fertility rather than declining mortality.

Infant mortality rates for divisions of the population were examined to estimate differentials and trends in those differentials (see Figure 4). Rural infant mortality was nearly twice that of Istanbul-Izmir in the late 1940s, with other urban places intermediate between the two. The differentials shrink over time, but infant mortality in rural areas was still almost two-thirds higher than in Istanbul-Izmir in the late 1960s. Estimates made separately by regions of the country suggest that there were sizeable differentials within the rural population in the late 1940s, but these regional differentials had largely disappeared by the late 1960s.

The decline of national infant mortality is connected with the divisional trends of infant mortality by the distribution of births among the divisions. As young adults migrate from rural to urban areas, the distribution of births shifts. Trends in the number of births by divisions show that urban births are increasing while rural births, though increasing at first, leveled off by the late 1960s. The rearing of proportionately more infants in urban family and community surroundings, which have lower risks of death than rural settings, contributes to the national decline.

POPULATION GROWTH

The trend of population growth in Turkey reflects births, deaths, and the international balance of migration (see

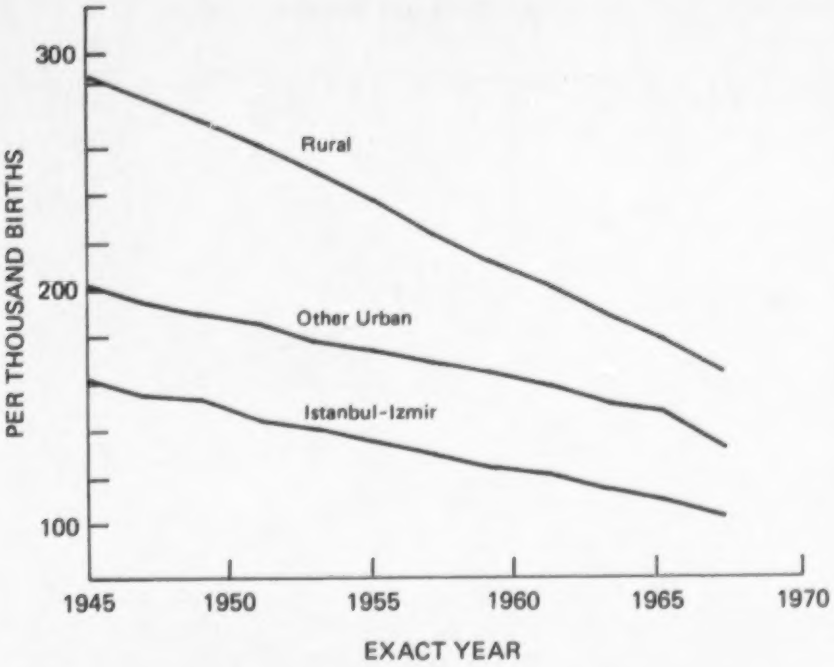


FIGURE 4 Infant Mortality Rates by Rural-Urban Areas, 1945-67: Turkey

Figure 5). The latter component was of little importance until the 1960s, when worker migration became a major economic factor with important demographic implications. Precise estimation of the volume of movements is impossible. There was a net loss of nearly one million persons from 1960 to 1975 (an estimate of 908 thousand is used in this report). The total number of Turks moving to other countries was some multiple of this figure, but many of these guest workers and their families returned to Turkey. In a population that was 40 million by 1975, the cumulative draw-down of the national population at home was not negligible. However, on an annual basis the effects on the total growth rate are rather moderate. The main components of population change over time are births and deaths.

The decline in mortality brought an increase in the growth rate, to a level averaging 2.8 percent per annum during the 1950s. Falling fertility and worker migration reduced the rate to approximately 2.4 percent per annum in the early 1970s. Declining fertility is a double-edged sword. Initially, it lowers the death rate through its

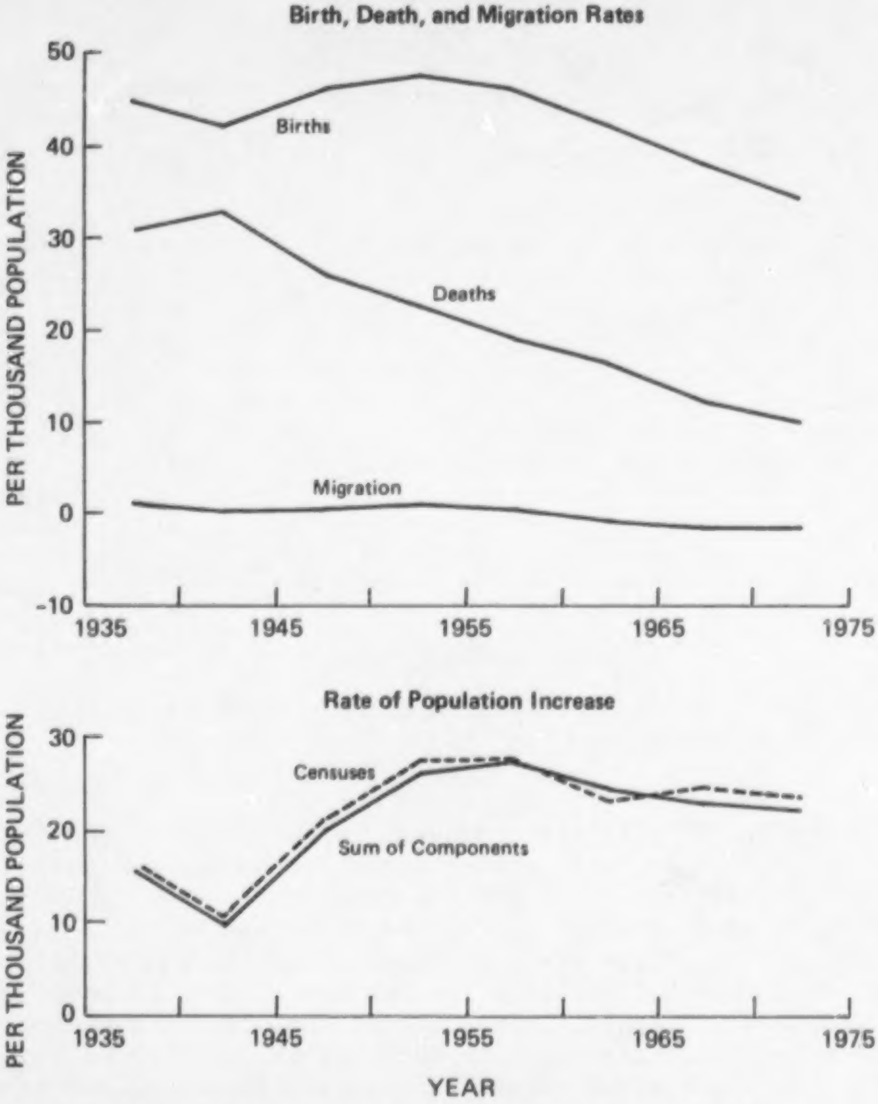


FIGURE 5 Overall Rate and Components of National Population Increase, 1935-75: Turkey

effects on the age structure at the same time as it lowers birth rates. The latter effect is, of course, the stronger one, and in time the effect on age structure disappears, due to aging of the reduced-size cohorts. Thus, the decline in fertility has not only brought a modest reduction in the growth rate, but has positioned the structure of the population for more decline in the future.

Combining estimates of the birth, death, and migration rates gives estimates of the total growth rate that are not much different from those estimated simply by comparing totals from one five-year census date to the next. This degree of consistency between the estimates of this report and the census-based growth rates is not altogether accidental, because the census data themselves play a major role in the estimation procedures. However, there are some important elements of independence between the two procedures for estimating the growth rate. Estimates for each component rest partially on independent data or on indirect techniques of measurement that are partially independent of changes in census coverage over time. Hence, general agreement of the sum of the components with the census growth rate is encouraging, but it is not conclusive assurance of accuracy.

1 Introduction

BACKGROUND

Turkey is the largest country in Western Asia, with a population of about 45 million in 1980. The country has extensive coastal areas on the Mediterranean, Aegean, and Black seas; extensive upland plains and hill areas including Central Anatolia; and rugged mountainous regions in the east and south. Turkey's political and territorial integrity date from 1923 when the Turkish Republic was founded. Fertility has declined in the past two and a half decades, but the extent of decline and the levels of recent fertility and mortality have not been estimated consistently by all observers.

Turkey has a variety of demographic data sources which have been used to estimate fertility and mortality levels and trends for the nation and for six divisions of the population. These data sources are reviewed in detail in this introductory chapter. Chapter 2 presents fertility estimates, Chapter 3 mortality estimates, and Chapter 4 discusses the cumulative effects of the various components of national population growth. Appropriate demographic techniques have been applied in constructing the estimates described below, among them a new technique called multiple reverse projection, which is described in detail in Appendix A. Appendix B describes a special technique used to estimate infant and early childhood mortality from birth-survival histories. Appendix C explains how census data were adjusted to correct for age misreporting, and Appendix D presents the available data on international migration from Turkey. Appendix E presents data on the population of six divisions of Turkey by age and sex as reported in the censuses from 1945 to 1970.

DATA SOURCES

Turkey conducted nine quinquennial censuses between 1935 and 1975. National-level data from the 1975 census are available only from a 1 percent sample of the census data, but more complete tabulations are available for the earlier censuses. Two national demographic surveys of the dual-record type have been conducted, the Turkish Demographic Survey of 1965-68 and a similar survey in 1974-75. Three national population surveys that included fertility histories and child-survival information were conducted in 1963, 1968, and 1973. A Turkey Fertility Survey was conducted in 1978 in collaboration with the World Fertility Survey, but those data were not available for use in this report.

Births in Turkey are registered for legal purposes, but the registration information is not cumulated for national statistical purposes and published. Death registration data for all district and province centers are available and these data sets have been examined. No death registration data are available for other cities or for villages. Also, fertility and mortality data are available from two special health training and research areas: the Etimesgut Rural Health District and the Yozgat (Province) Maternal, Child Health, and Family Planning Project.

Censuses

The first modern census was taken in 1927 but the series useful for demographic analysis begins with the report of the 1935 census. Turkey possesses an unbroken series of censuses from 1935 to 1975 at five-year intervals. The censuses were all taken at the same time of year and by essentially the same de facto counting procedures. Reports for the nine censuses are available in comparable detail for most years. Additional detail comes from the separate provincial volumes produced in 1935 and 1970. A 1 percent sample of the 1975 census is available, but the planned provincial volumes are incomplete and the national report was not available for use in this report. Questions on age and sex are tabulated in comparable five-year age groups for all dates at the national level; the results are summarized in Table 1. Marital status was not tabulated in 1940 and lacks standard five-year age groups above age 25 in 1950.

TABLE 1 Population of Turkey by Age and Sex as Reported in the Censuses, 1935 to 1975[a] (in thousands)

Age	1935[b]	1940	1945	1950	1955	1960	1965	1970	1975[c]
Males									
0-4	1,454.8	1,387.0	1,288.4	1,585.1	1,985.5	2,184.7	2,359.3	2,661.7	2,765.2
5-9	1,230.2	1,419.0	1,350.1	1,338.5	1,677.0	2,076.9	2,418.8	2,611.0	2,795.7
10-14	862.7	1,190.0	1,286.5	1,275.6	1,295.8	1,691.2	2,061.1	2,363.4	2,728.7
15-19	567.8	829.7	1,050.0	1,271.3	1,248.3	1,249.9	1,548.6	1,924.7	2,314.2
20-24	761.4	524.5	790.0	990.9	1,210.2	1,178.2	1,213.1	1,496.6	1,833.1
25-29	632.1	684.6	484.9	727.0	959.5	1,157.5	1,056.7	1,108.2	1,452.3
30-34	594.0	618.6	732.1	524.3	749.0	1,028.3	1,140.4	1,019.2	1,092.6
35-39	494.4	590.5	608.1	688.4	519.5	749.7	999.1	1,117.4	1,034.3
40-44	328.9	466.4	543.0	552.0	666.8	506.0	705.8	921.5	1,095.2
45-49	246.9	303.3	401.8	499.8	525.0	610.4	446.2	644.7	903.6
50-54	229.5	248.2	283.2	389.6	505.4	548.5	613.1	457.1	654.5
55-59	164.8	175.2	171.3	214.3	327.2	424.7	450.2	497.1	388.8
60-64	178.2	190.2	200.1	197.1	243.1	369.0	453.5	476.5	517.5
65-69	101.9	100.1	98.8	114.5	126.4	166.5	258.3	321.6	353.4
70-74	92.5	83.1	80.1	77.3	98.5	113.9	145.9	220.9	261.9
75+	89.4	88.1	78.1	81.3	96.3	108.5	126.8	165.4	226.2
Sub-total	8,030	8,899	9,447	10,527	12,233	14,164	15,997	18,007	20,417

Females									
0-4	1,318.2	1,258.0	1,186.5	1,509.3	1,879.4	2,078.9	2,264.8	2,594.8	2,652.5
5-9	1,146.3	1,266.0	1,244.1	1,238.3	1,562.0	1,927.7	2,252.3	2,484.0	2,665.9
10-14	758.0	991.2	1,075.6	1,082.2	1,090.6	1,488.5	1,812.3	2,167.3	2,495.7
15-19	493.7	698.9	932.7	1,119.7	1,088.1	1,059.2	1,365.8	1,770.7	2,160.2
20-24	650.5	518.6	692.6	974.2	1,111.1	1,127.9	1,134.5	1,355.5	1,713.9
25-29	732.9	705.9	620.0	752.6	1,021.7	1,177.3	1,162.6	1,154.0	1,394.4
30-34	652.4	715.9	700.6	591.3	731.3	985.8	1,135.9	1,165.7	1,098.9
35-39	517.8	568.7	579.2	600.7	525.8	693.8	935.8	1,097.3	1,141.3
40-44	481.6	530.7	558.8	595.9	621.5	548.4	677.7	900.0	1,065.8
45-49	319.9	348.4	379.0	445.8	473.1	500.0	430.1	564.1	826.0
50-54	390.6	416.5	434.7	472.0	528.2	581.3	591.6	516.3	645.3
55-59	198.4	217.3	219.7	260.5	308.8	369.4	415.6	440.6	392.3
60-64	302.2	327.4	349.7	359.2	387.3	461.4	502.1	529.9	551.8
65-69	106.6	114.1	124.8	154.4	172.8	213.8	271.5	319.4	370.4
70-74	128.1	131.2	133.2	138.2	171.2	195.7	221.0	265.5	298.0
75+	119.9	114.1	112.4	125.8	158.5	188.1	220.9	273.2	308.1
Sub-total	8,317	8,922	9,344	10,420	11,831	13,591	15,394	17,598	19,780
Total	16,347	17,821	18,790	20,947	24,065	27,755	31,391	35,605	40,198

Note: Numbers add correctly to totals; rounding of age groups and of totals independently gives the appearance of different totals.

[a] Persons with ages reported as unknown were redistributed in proportion to the number of persons in each age group at each census.

[b] Adjusted from 16,158 to 16,347 to correspond with national boundaries after the annexation of Hatay in 1939.

[c] Preliminary data from a one percent sample of the 1975 census.

This rich series of censuses implicitly contains the history of mortality and fertility for Turkey except for changes in population due to territorial change or international migration. The only territorial change between 1935 and 1975 was the annexation of Hatay Province in 1939. International migration became an important influence on population size and age structure with the worker movements of the 1960s and 1970s. Information with which to assess recent migration is available from special surveys by the State Planning Organization and the censuses of the principal worker-receiving country, the Federal Republic of Germany. For earlier periods, special studies on population exchanges of minor demographic significance are available.

For subdividing the population into rural-urban and geographic divisions, data are available between 1945 and 1970 on age, sex, and marital status, classified by places with populations above and below 10,000. These data are available either from census reports (1970) or from the archives of the State Institute of Statistics. Demographers who have copied information from the archives and placed it in computer-readable form kindly made these materials available.

The 1965 boundaries of provinces were used as the standard for aggregating data by the six geographic rural and urban divisions. Adjustments for changes in boundaries prior to 1965 were made with information from Kemal Ozok's meticulous compilation (Turkey, Regional Planning Office, 1968). There were no further changes in province boundaries after 1965, so the six divisions for 1970 have the same boundaries as 1965 and the adjusted data for earlier dates. For some years, data on marital status by sex and five-year age groups are deficient below the national level. However, data are sufficient to compile age-sex distributions for 1945-70.

The 1970 and 1975 censuses asked about the cumulative fertility of ever-married women (total number of children born alive) and the survival status of their children (total number of children still living). These data are valuable for indirect estimation of infant and early childhood mortality when the tabulations include (1) numbers of children ever born and numbers surviving, cross-classified by five-year age groups of mothers from 15 to 34; and (2) distributions of all women by marital status by at least the same five-year age groups. Matching tabulations of (1) and (2) are available at the national level for 1970 and for the 1 percent sample of the 1975 census. The necessary coordination between tabulations of types (1) and (2) was not fully achieved for the rural-urban division of population in 1970 because province-level tabulations of type (1) refer to the administrative definitions of rural and urban, whereas those of type (2) refer to places with populations under and over 10,000. The second method of distinguishing rural and urban is preferable because it matches the dividing criterion used for age and sex distributions for Turkish censuses. Reports for provinces from the 1975 census are incomplete; some province reports show age and sex by the 10,000-population division of rural and urban, but they do not include any tabulations of types (1) and (2).

The 1970 and 1975 censuses also asked a question about the number of children born alive who died before reaching age 1. This question does not provide a reliable basis for infant mortality measurement, because misreporting of age at death is severe and the time in the past to which the mortality experience refers is unclear. In its place, the Panel suggests using a question on whether each ever-married woman had a live birth during the last year. The new question would provide a basis for estimating the current age pattern of fertility, provided it is tabulated by ages of mother in five-year age groups. In combination with other census data, this question would help to provide estimates of fertility levels in terms of crude birth rates and total fertility.

National Dual-Record Demographic Surveys

The Turkish Demographic Survey (TDS) was conducted between 1965 and 1968 by the School of Public Health in the Ministry of Health. A national area sample of 40,000 households was used to collect data on births, deaths, migrations, and population structure. The TDS used a monthly recording system and a semi-annual independent survey. Thirteen rural and urban subdivisions of the population were defined and brought into the national sample sequentially until all units were simultaneously under surveillance by June 1966. Complete national data are available for 1966-67 (Turkey, School of Public Health, 1970). The TDS estimates of birth and death rates are made by standard dual-record methods that include an estimate of omissions by both record systems.

In 1974, a second-generation TDS called the Turkish Population Survey (TPS) was started in the State Institute of Statistics. Its first report, for 1974-75, is available (Turkey, State Institute of Statistics, 1978), but the procedures for data collection and processing are not sufficiently well documented to permit an evaluation of the results. Consequently, these data were not used in this report.

National Population Surveys

The Ministry of Health held a national population survey in 1963, which included both a representative demographic sample of approximately 8,000 ever-married women and a subsample of 2,600 currently married women. Questions on contraceptive knowledge, attitudes, and practices were the main purpose of the subsample. Data concerning marital fertility and early childhood mortality from the 1963 demographic sample of 8,000 women are available.

In 1968, a representative national sample of 3,300 currently married women was interviewed in the Survey on Family Structure and Population Problems of the Institute of Population Studies of Hacettepe University. This included information on the fertility of currently married women, comparable to the 1963 survey. The same fertility questions were included in a third national survey of 4,600 currently married women conducted by the Hacettepe Institute in 1973.

Reports and tabulations from the 1968 and 1973 surveys are available for the country as a whole and for subdivisions that differ somewhat from the six population divisions used by the Panel. Special tabulations of birth histories and the survival of the children are available according to the Panel's six divisions from the 1968 and 1973 surveys. Of the two, only the 1968 tabulations are accompanied by sufficient information about the preparatory data processing to allow them to be evaluated. The 1968 data were therefore judged to be more useful and were used as one basis for estimating child mortality trends (see Chapter 3).

Birth and Death Registration

Birth registration is required in Turkey, and most persons have birth cards. However the system is not used to generate national statistics on birth events. Death registration is also required. Death statistics are gathered from the registration system by the Ministry of Interior for all cities and towns that are provincial or district headquarters. These data are published by the State Institute of Statistics. An evaluation by Kadir Sumbuloglu for 1960 to 1975 shows that underenumeration of deaths varies among cities and at different dates with no detectable systematic pattern that would permit adjustment. There is, in addition, differential omission of infant deaths (Sumbuloglu, 1978).

National Life Tables

A Turkish national life table is available based on data from the Turkish Demographic Survey. Life tables of apparently sound quality are also available for a nine-year period from the Etimesgut Rural Health District (population of 80,000 persons) and from the Yozgat provincial health project (population of 500,000 persons), which utilized a dual-record sample of 50,000 persons (Institute of Community Medicine, 1975; Tekce, 1979).

2 Fertility

NATIONAL CRUDE BIRTH RATES, 1935-75

A common technique for estimating fertility is reverse survival. In this report a more refined reverse survival alternative is applied. The following sections describe the general technique, the alternative used here and resulting estimates of crude birth rates. Estimates of crude birth rates by other means are also compared.

The General Technique of Reverse Projection

Measures of fertility for the years preceding a census can be estimated by projecting in reverse the number of persons at different ages at a given time before the census. Thus, the crude birth rate _t_ years before the census may be estimated by reverse projection to birth of the number of persons aged _t_ at the time of the census, combined with reverse projection of the whole population to determine the appropriate denominator for the birth rate _t_ years before the census.

The accuracy of an estimate of fertility for a particular time period derived by reverse projection depends on how well the projection allows for the actual change in the populations that form the numerator and denominator of the crude birth rate and on how accurately the census recorded the subgroups that were projected to form the numerator and denominator of the fertility measure. Since the birth rate is a ratio, however, equal proportionate errors in counting or projecting the two groups that form the numerator and denominator (for example, a 5 percent undercount of both populations or a 2 percent overstatement of the proportion surviving in each group) would still allow an accurate estimate of the birth rate. Therefore, changes in the extent of coverage from one census to the next, which has been a problem in Turkey, do not bias the fertility measure provided the under- or overenumeration is proportionate across the age groups used in calculating the numerators and denominators of the fertility measures.

Misreporting of age, which moves individuals from one age (or age group) to another, causes spurious intertemporal variation in fertility estimates derived by reverse projection. For example, systematic overstatement of age such that the true number of people under age 5 is understated and the number in the next age group (5-9) is overstated, creates the appearance of a decline in fertility from the period 5 to 10 years ago to the period 0 to 5 years ago. In Turkey, there is systematic age misreporting of the pattern just described. If the age distribution is distorted by age misreporting in the age groups that are projected, the trends of fertility that are estimated will be spuriously erratic.

The Turkish censuses extend backward in time from 1975 to 1935 at nearly exact five-year intervals. The data they provide are ideal for making estimates of fertility through reverse projection as long as appropriate assumptions about mortality can be made and the problems created by age misstatement can be overcome. Chapter 3 explains how mortality estimates were made to meet this first requirement. The solution to the other problem, that of age misstatement, may be approached in two different ways.

One approach is to adjust the censuses data for age misreporting. No attempt to correct for general coverage errors is necessary, because this type of error, as already explained, does not affect reverse-projection estimates of the crude birth rate. The method used to make these corrections for the Turkish censuses is explained in Appendix C. However, no known method is capable of eliminating all error due to age misstatement. The resulting reverse projections of fertility from a census adjusted for age misreporting are imperfect to the same extent.

Multiple Reverse Projection (MRP)

An alternative approach, suggested by Frederic Shorter, is called "multiple reverse projection" (MRP). Described in detail in Appendix A, this method has also been applied to the Turkish censuses. From each census, a time series of estimates of fertility is constructed by reverse projection. The series goes back in time from the date of the census as far as assumptions based on mortality estimation are warranted. This procedure gives fertility estimates for years _t_ to _t_+5 years before the census, based on births whose survivors are in the age group _t_ to _t_+5 of the census. For example, the births for the period 20 to 25 years before the census are calculated from the age group 20-25 in the census. The denominator of the crude birth rate is an estimate of the total population size during the same period 20 to 25 years before the census, which is also given by the reverse projection. When a sequence of censuses is available, an independent time series of fertility estimates can be calculated from each census.

In all reverse projections, there is a theoretical problem concerning how to "close" the population at the uppermost ages. In actual data the uppermost age group is an open-ended interval. For example, the Turkish data are divided into five-year age groups up to age 75 with an open-ended interval of "75 and over" as the last group. The population in this open age group consists of persons who were ages 70-74 and 75+ five years earlier. In order to use the survival rates of the life table to project backward in time, it is necessary to know how the population was divided between individuals less than 75 (those in the 70-74 age group) and those who were already 75 or over. Assumptions can be made and the errors in those assumptions will have little effect on a crude birth rate only five years earlier, because population size, the denominator of the crude birth rate, will be affected very little by the error. However, as the reverse projection extends further backward in time, errors in population size due to such assumptions are magnified and can create misleading results.

The multiple reverse projection method offers a simple solution that makes use of the data from prior censuses. While the total size of these prior censuses may not be correct, the relationship between the size of the open age interval and the next lower age interval can be accepted. That relationship is based on actual census data and reflects all the conditions of fertility, mortality, and migration in the past that have influenced the distribution by age at the uppermost ages. Multiple reverse projection uses this information from prior censuses to "close" the reverse-projected age distribution at the highest ages.

For Turkey, a series of crude birth rates from 1935 to 1975 was calculated from the 1975 census, a series from 1935 to 1970 from the 1970 census, and so on. Thus, eight independent estimates of the crude birth rate were made by reverse projection for the time period 1935-40, seven for 1940-45, and so on, creating multiple estimates for each five-year period. They vary among themselves for a given period to the extent that age misreporting has distorted the different age groups that are the basis of the single estimates. However, a shortage of persons in one age group due to age misstatement necessarily means an excess count of persons in another age group. When the age misreporting pattern is stable from one census to the next, the shortages and excesses occur in the same age groups in every census. Hence, birth rates for a given period that have been estimated from a series of censuses are based partly on overstated age groups and partly on understated age groups. Upward error due to age error in one census is matched by downward error in another census. Therefore, a strong estimate of the crude birth rate for a particular period is an arithmetic mean of the multiple estimates for the period.

Gains and losses in population due to migration in the past affect the number of survivors shown in the current age distribution. Therefore, migration must be included as one of the determining components of the reverse projection if migration is significant. During the 1960s and 1970s, worker migration to Europe became an important demographic influence in Turkey. Earlier there were smaller movements, principally as Turks in the Balkan countries relocated in Turkey. Estimates of migration were constructed independently from the reverse projection (as described in Appendix D), then introduced as component determinants of the reverse projection. The available distributions of migrants by age are only approximate, which causes distortions in the reverse-projected cohorts. These errors are similar to those of age misreporting and are mutually offsetting in the context of multiple reverse projection.

MRP Estimates of Crude Birth Rates

Multiple reverse projection was applied to the Turkish censuses first without any adjustment for age misreporting, and then with adjustment. The resulting estimates of the crude birth rate, shown in Table 2, were then averaged for each period of estimation. For every period of estimation from 1935 to 1975, the average estimates based on corrected and uncorrected age data are almost identical, except for the last, 1970-75. The reason for such excellent agreement is that the errors of estimation caused by age misreporting are offsetting errors. A valuable conclusion from this comparison is that the Turkish estimates of the crude birth rate do not depend upon the accuracy of adjustments for age misreporting. Indeed, robust estimates of the crude birth rate can be made without going through the prior step of correction for age misreporting.

The success of the method without adjustment being needed for age misreporting depends upon having more than one census from which to make estimates of the birth rate for a period. If data from only one census are used, the estimate of births for five years prior to that census typically lies below an estimate from multiple censuses (see Figure 6), because the 0-4 age group is understated by age misreporting. Single-census estimates of the

TABLE 2 National Crude Birth Rates, 1935-75, Estimated by Multiple Reverse Projection: Turkey

Period of Estimation	Census Year								Average of All Possible Censuses	Number of Reverse Projections
	1975	1970	1965	1960	1955	1950	1945	1940		
Part A. Estimates Based on Reported Age Distributions										
1935-40	46.5	45.1	44.2	44.5	45.4	46.2	50.0	44.7	45.8	8
1940-45	43.1	42.8	43.4	42.0	43.7	47.0	41.2	--	43.3	7
1945-50	45.0	44.3	44.9	48.5	49.4	43.9	--	--	46.0	6
1950-55	46.3	48.1	50.0	50.7	46.4	--	--	--	48.3	5
1955-60	47.9	48.5	49.2	42.4	--	--	--	--	47.0	4
1960-65	46.0	44.8	38.9	--	--	--	--	--	43.2	3
1965-70	40.0	37.6	--	--	--	--	--	--	38.8	2
1970-75	33.0	--	--	--	--	--	--	--	33.0	1
Part B. Estimates Based on Age Distributions Corrected for Age Misreporting										
1935-40	45.6	43.9	44.5	45.3	45.9	45.3	47.3	46.8	45.6	8
1940-45	41.9	43.0	44.2	42.1	42.6	44.6	43.0	--	43.1	7
1945-50	45.2	44.9	45.1	47.2	47.3	45.7	--	--	45.9	6
1950-55	46.9	48.1	48.7	49.0	48.4	--	--	--	48.2	5
1955-60	47.9	47.2	47.7	44.3	--	--	--	--	46.8	4
1960-65	44.7	43.4	40.7	--	--	--	--	--	42.9	3
1965-70	38.6	39.3	--	--	--	--	--	--	39.0	2
1970-75	34.5	--	--	--	--	--	--	--	34.5	1

Note: Rates are per thousand.

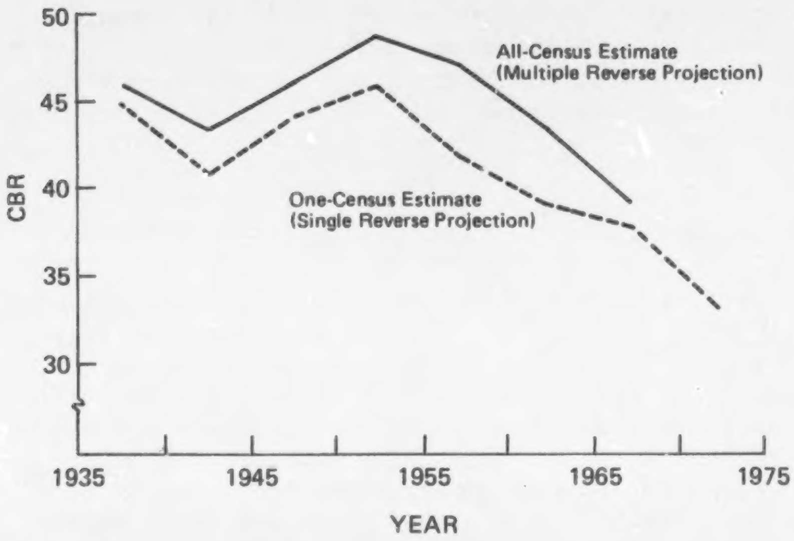


FIGURE 6 Estimates of Crude Birth Rate Based on Reported Age Distribution from One Census at End of Five-Year Period and Estimates Based on Distribution from all Available Censuses, 1935-75: Turkey

birth rate, therefore, are vulnerable and not acceptable. The extent of understatement by comparison with estimates from more than one census varies with age misstatement. Taking all multiple-census estimates (two or more), they average 5.9 percent higher than the single-census estimates, with a standard deviation of 3.5. If this degree of understatement is accepted as typical, an acceptable way to estimate the crude birth rate for 1970-75 is to raise the estimate based on one census of 33.0 per thousand by 5.9 percent to 34.9 per thousand. The result is then subject to a range of error of ± 1.2 per thousand population.

Other Estimates

Independent confirmation of the trend in crude birth rates can be sought in other estimates of the crude birth rate that are available for the periods 1955-60, 1966-67, and approximately 1970, each based on different types of data or methods. In the next section, total fertility rates are derived from the crude birth rate and also compared with independent estimates. This procedure provides further checking of the crude birth rate by confirming its implications.

The birth rate for 1955-60 was estimated by Demeny and Shorter (1968) using two different methods of indirect estimation:

Demeny-Shorter (1)

The first method calculated the natural intercensal rate of increase from the migration-adjusted census totals for 1955 and 1960. The death rate was then added to this to produce the birth rate. To determine the death rate, deaths above age 5 were calculated from model life tables; death rates from the table were multiplied by the mid-period census population in each age group. The model life table was selected using the intercensal forward-projection procedure (described in Chapter 3). Below age 5, the death rate was taken from a life table selected by the Brass child mortality method, using data from the 1963 national sample survey. (The Brass method is explained in Chapter 3.) There are two child mortality estimates (I and II) that describe the acceptable range. The crude birth rates for 1955-60 found by this approach were 46.6 (I) and 44.7 (II) per thousand.

Demeny-Shorter (2)

The second method used the reported population under age 10 from the 1960 census to make a single reverse projection. Since the errors in the two five-year age groups below age 10 proved to be offsetting (see Appendix C), the reported proportion of total population under age 10 is relatively accurate. For the reverse projection, the two child mortality estimates mentioned above (I and II) were used to obtain two alternative estimates. Alternative birth rates were calculated with the aid of tabulated stable populations (Coale and Demeny, 1966). A model life table was chosen on the basis of the $_2q_0$ value (proportion dying up to age 2); then the birth rate associated with a given proportion under age 10 was found from the tabulated stable population based on that model life table. This is an efficient and only trivially biased method for making reverse projections over short periods of time. Moreover, the method is not sensitive to the selection of a particular family of life tables so long as mortality is within the range of "normal" variation. Because Turkish mortality is strongly deviant (see Chapter 3), this characteristic imparts a slight downward bias to estimates of the birth rate derived by this method.

The common element of the two Demeny-Shorter methods is the estimate of mortality rates under age 5, which has two alternative values. The reliance on alternative child mortality rates (CMR) is noted below. As a result, two different measures of the crude birth rate (I and II) are produced for each indirect method of estimation. In other respects, methods (1) and (2) rely on different data and to that limited extent the estimates they produce are partially independent. The results for 1955-60 are crude birth rates as follows:

Method of Estimation	Estimate I (High CMR)	Estimate II (Low CMR)
1. Components of population change between two censuses	46.6	44.7
2. Reverse projection by tabulated models from a single census	46.3	44.5

A 1 percent sample of the 1975 census provides a basis for estimating the crude birth rate around 1970 using the second Demeny-Shorter method explained above (Özbay et al., 1977). The census included questions on number of children ever born and surviving; hence, an indirect estimate of child mortality could be calculated from the census itself, utilizing the Brass-Trussell method explained in Chapter 3. The proportion of the population under age 10 in the 1975 census was used for the single reverse projection. The resulting estimate of the crude birth rate is 35.8 per thousand. Since the mortality information on which this estimate is based refers to about 3.1 years before the census on average, and the information on survivors of births refers to a ten-year period prior to the census, there is an imperfect match of dates for the parameters. The birth rate estimate refers to a date circa 1970.

Turkish Demographic Survey Estimates

For 1966-67, the Turkish Demographic Survey (TDS) provides a preliminary estimate of 37.3 per thousand for the crude birth rate. The estimate is from a national household demographic survey conducted as part of a dual-record statistical system, in which births were found by both monthly visits and half-yearly surveys. When the dual-record methodology (see glossary) is applied, there is an upward adjustment for birth events missed by both systems; the final TDS estimate of the crude birth rate for 1966-67 is 39.6 thousand.

Estimates Based on National Fertility Surveys

The national surveys of the fertility of married women conducted in 1963, 1968, and 1973 do not provide a robust basis for the independent estimation of crude birth rates. The reasons are two: the sample size of the surveys is too small to allow the estimation of annual rates from only one year of events, and a number of design features place limits on how the data can be used.

Table 3 summarizes the CBR estimates derived from the various estimation procedures described above.

TABLE 3 Summary of National Crude Birth Rate Estimates, 1935-75: Turkey

	Period of Estimation							
Method of Estimation	1935-1940	1940-1945	1945-1950	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975
Multiple Reverse Projection								
Reported age distribution	45.8	43.3	46.0	48.3	47.0	43.2	38.8	34.9[a]
Corrected for age misreporting	45.6	43.1	45.9	48.2	46.8	42.9	39.0	34.5
Demeny-Shorter (1)								
CMR I	--	--	--	--	46.6	--	--	--
CMR II	--	--	--	--	44.7	--	--	--
Demeny-Shorter (2)								
CMR I	--	--	--	--	46.3	--	--	--
CMR II	--	--	--	--	44.5	--	--	
1975 Census	--	--	--	--	--	--	--	35.8[b]
Turkish Demographic Survey	--	--	--	--	--	--	39.6[c]	

[a] Based on a single-census estimate that is adjusted as explained in the text.
[b] Circa 1970.
[c] 1966-67.

NATIONAL TOTAL FERTILITY RATES, 1935-75

The trend of the crude birth rate (Table 3 and Figure 1) gives a less than complete description of the onset of fertility decline in Turkey. The age structure of the Turkish population was seriously scarred by excess infant and adult mortality during the Balkan wars and Turkey's own war of independence, which ended in 1922. Female birth cohorts affected by these events were passing through their childbearing years as late as the 1960s. These true irregularities of age and sex composition have themselves affected crude birth rates separately from the general trend of declining childbearing rates. It is useful, therefore, to evaluate the trend of fertility from the standpoint of the total fertility rate.

The total fertility rate describes the average total number of children born to a woman according to the current age-specific fertility rates (see glossary). Since the number of births in any year depends upon the number of women in each childbearing age group as well as on the age-specific fertility rates, there are two factors underlying the crude birth rate. The total fertility rate isolates and measures only the fertility component, leaving aside the effect of changes in age and sex distribution.

The following substitution procedure is used to calculate the total fertility rate (T) that implies the same number of births (B) as the crude birth rate:

$$T = 5 \cdot \sum_{i=1}^{7} \left[\frac{B}{B^*} \cdot F_i^* \right] \text{ where } B^* = 5 \cdot \sum_{i=1}^{7} \left[F_i^* \cdot \overline{W} \right]$$

W refers to the proportion of women in an age group i in the total population (both sexes), and F_i^* refers to a standard fertility distribution by age for the population in question. The age pattern, but not the level, of this fertility schedule determines T.

Standard Fertility Schedules

Any reasonable choice of fertility schedule provides a satisfactory basis for deriving the total fertility rates from crude birth rates. For Turkey, data are available to make this choice with some precision. A standard distribution of age-specific fertility is constructed from data on age-specific marital fertility and proportions married by age. Marital fertility schedules are available from national sample surveys (Table 4), and marriage proportions are available from the censuses (Table 5).

The marital fertility schedule for Turkey (shown in Figure 7) has a shape that characterizes populations practicing fertility control by contraception. When compared with a natural fertility schedule (one with no deliberate control), there is a noticeable clockwise rotation. This difference is due to birth limitation during the older ages of marriage. The rising trend of contraceptive control in Turkey is also confirmed by independent data on the prevalence of contraceptive use

TABLE 4 Percentage National Distribution by Age of Marital Fertility, 1963-73, Compared with a Schedule of Natural Fertility: Turkey

		National Sample Surveys			
Age Group	Natural Fertility	1963	1966-67	1968	1973
15-19	18.4	20.8	20.0	19.0	21.5
20-24	21.0	24.7	24.7	23.5	25.8
25-29	19.8	20.6	21.0	20.7	21.6
30-34	17.8	16.5	16.5	16.6	15.8
35-39	14.4	11.8	11.9	13.1	10.9
40-44	7.5	4.6	5.0	6.2	3.6
45-49	1.1	0.9	1.0	1.0	0.7
Total	100.0	100.0	100.0	100.0	100.0

Sources:

1963: Ministry of Health survey. Marital fertility is available from reports of births during the last year by mothers aged 15-44. Original data are extended by extrapolation to the 45-49 age group. An age adjustment is made to match age with births occurring an average of 6 months before the survey.

1966-67: Turkish Demographic Survey. Births are available by age of mother at time of birth. The numbers of married women are available for five-year age groups only up to age 24 and for ten-year age groups thereafter. Marital status information from the censuses of 1965 and 1970 was used to split the ten-year age groups. The fertility rate for ages 45-49 was extrapolated.

1968: Hacettepe survey; same type of data as in 1963.

1973: Hacettepe survey; same type of data as in 1963 and 1968. A direct estimate is available for the age group 45-49.

Natural Fertility Schedule: This is a standard schedule from Coale, Hill, and Trussell (1975).

TABLE 5 National Proportions of Females Married by Age, from 1935-75 Censuses: Turkey

Age Group	Census								
	1935	1940	1945	1950	1955	1960	1965	1970	1975[a]
15-19	.232	(.245)	.258	.313	.396	.333	.273	.247	.213
20-24	.802	(.796)	.790	.822	.848	.839	.827	.794	.749
25-29	.910	(.910)	.910	(.912)	.913	.941	.940	.931	.915
30-34	.911	(.914)	.916	(.915)	.914	.946	.954	.953	.942
35-39	.877	(.886)	.895	(.904)	.912	.933	.940	.948	.940
40-44	.768	(.799)	.830	(.851)	.872	.893	.904	.918	.913
45-49	.653	(.706)	.758	(.790)	.822	.855	.860	.879	.878

Note: Parentheses indicate that data are not available. Estimated values were inserted by linear interpolation between adjacent pairs of censuses.

[a] Based on a 1 percent sample of census data.

(Table 6). Studies of trends in the types of contraceptives that are used show, in addition, that progressively more effective methods are being used (Fisek, 1978).

It could be assumed that the marital fertility pattern in Turkey in the 1930s was not much different from a natural fertility pattern, and that it changed primarily after the post-war period (from 1945-50 onward), moving linearly to the 1963 and 1973 schedules. If these assumptions are accepted, Turkey would be described as having a changing pattern of marital fertility that follows the clockwise rotation noted above.

Total Fertility Rates

The multiple-reverse projections play a role in estimating total fertility rates (TFR) by providing estimates of the W values in Equation 1 (proportions of women in the populaton belonging to each age group), and by giving the numbers of births, B. A changing marital fertility pattern was assumed for the schedules of F_i^*, with results as follows:

Period	TFR
1935-40	6.66
1940-45	6.55
1945-50	6.85
1950-55	6.54
1055-60	6.54
1960-65	6.10
1965-70	5.63
1970-75	5.05

Alternatively, a single marital fertility standard, based on the 1963 pattern, could be assumed. The results of the two alternatives are shown in Figure 8. The assumption of a changing pattern is accepted as the most reasonable basis for calculating trends in the total fertility rate, but the range of possible overstatement of the total fertility level for the earlier years is

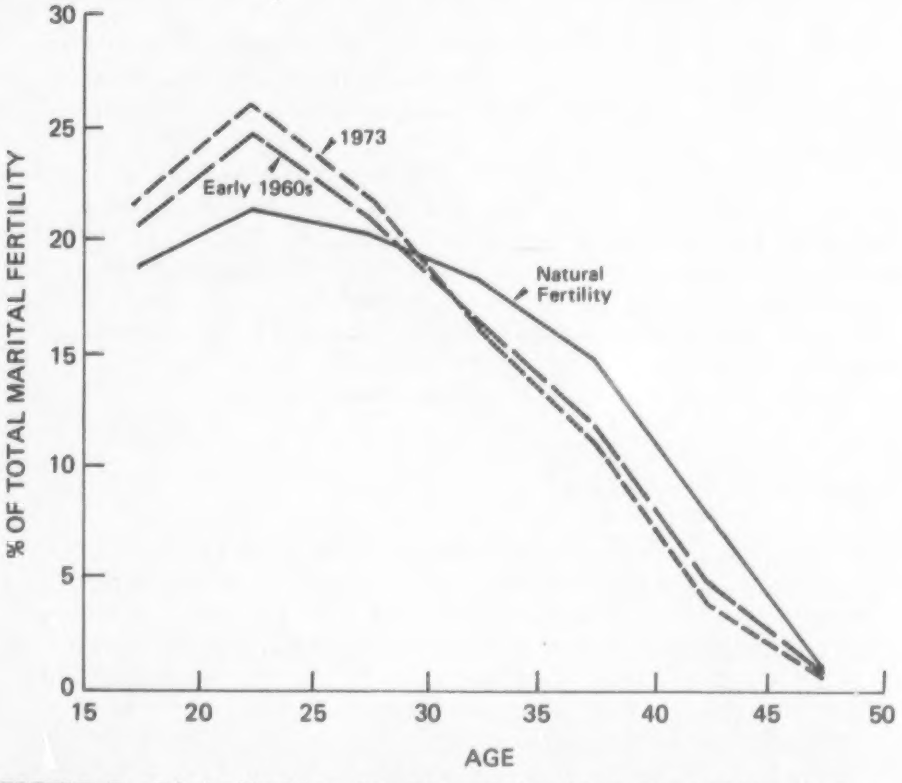


FIGURE 7 Distribution by Age of Marital Fertility Under Natural and Controlled Conditions, Early 1960s and 1973: Turkey

TABLE 6 National Proportions of Married Women Currently Using Some Method of Contraception by Age Group, Derived from National Sample Surveys in 1963, 1968, and 1973: Turkey

Part A. Number of Married Women Currently Using Some Method of Contraception (per thousand)

Birth Cohorts	Age at Interview <20	20-24	25-29	30-34	35-39	40-44
1919-23	--	--	--	--	--	175[a]
1924-28	--	--	--	--	241	320[b]
1929-33	--	--	--	279	369	314[c]
1934-38	--	--	259	416	442	--
1939-43	--	153	303	458	--	--
1944-48	89	247	435	--	--	--
1949-53	160	281	--	--	--	--
1954-58	160	--	--	--	--	--

Part B. Number of Respondents by Age Group

Sample Survey	Age Group <20	20-24	25-29	30-35	35-39	40-44
1963	143	435	577	598	452	350
1968	294	639	658	616	659	414
1973	342	819	774	709	839	649

[a] Diagonal shows estimates from 1963 survey.
[b] Diagonal shows estimates from 1968 survey.
[c] Diagonal shows estimates from 1973 survey.

Source: Özbay and Shorter (1970); Özbay (1979).

indicated by noting that use of the "early 1960s" pattern as a fixed standard would give somewhat lower estimates of the total fertility rate.

The point which is in doubt is the extent of deliberate fertility control in the 1930s. Differentials in marital fertility existed at that time between rural and urban, and between eastern and western Turkey. The size of the differentials apparently was substantial (Taeuber, 1958), but the proportionate weight of the lower fertility groups in the total population presumably was small, because the level of national fertility was high at that time. Since natural fertility itself can vary as to

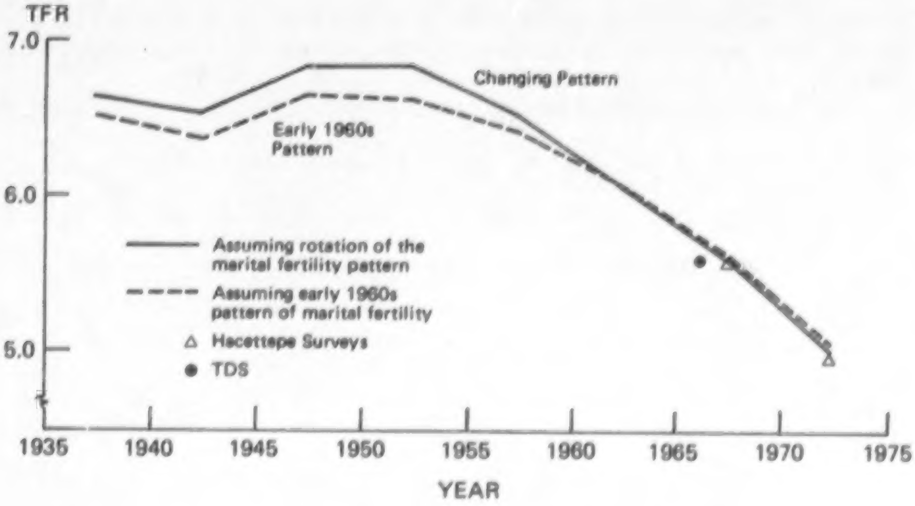


FIGURE 8 Estimates of Total Fertility Rate, 1935-75: Turkey

level, this could have been a contributory factor to the differentials of marital fertility in the 1930s, but the complete story remains obscure.

Other Estimates

The trend of total fertility rates may be checked for the more recent years by examining the results of fertility surveys that include information on both marital fertility and proportions married by age. The Hacettepe national surveys of 1968 and 1973 are of this type. The principal risk with this type of single-round survey data is a problem known as "reference-period error." When women (or other persons on their behalf) are asked to report births during the year preceding a survey, they easily become confused about the period being referred to or simply may not know whether recent births occurred exactly within the last year. When this happens, there is usually an accumulation of error which implies shortening or lengthening of the reference period, rather than offsetting errors.

The count of births in the 1973 survey illustrates how different results may emerge, the most probable cause of the differences being reference-period error. The 1973 survey contained two questions on the number of births in the last year. The first was included on the household questionnaire and was asked of the women, if they were available, but otherwise of an adult respondent, usually the head of household. The second was asked on a questionnaire administered only to the married women themselves. The second questionnaire collected a complete pregnancy history and great care was taken to date events as accurately as possible within the limitations of the respondents' knowledge and understanding. The first procedure yielded a total fertility rate of 4.66 children (Toros, 1978); the second, based on tables from the same survey, a rate of 5.00 children. Presumably the second is more nearly accurate than the first; however reference-period error remains as a distinct possibility.

Total fertility rates for the year preceding each of the Hacettepe surveys, which are subject to reservations about reference-period error, may be used as point-in-time estimates. These rates are also plotted in Figure 8 to be compared with the trend derived from crude birth rates.

Another estimate shown in Figure 8 comes from the Turkish Demographic Survey's dual-record system, which is less subject to reference-period error because of repeated interviewing of the same persons. Reported births, when raised by the standard dual-record adjustment for omissions, give a total fertility rate of 5.62 for 1966-67.

Finally, a preliminary TFR estimate for 1977-78 is given by the first report of the Haceteppe survey of 1978 (Hacettepe Institute of Population Studies, 1980), which was released after the Panel had completed its work. Based on births reported in the pregnancy histories, the estimated TFR is 4.3 children. Although this estimate is not shown in the figure, an extrapolation of the solid curve in that figure would give an estimate for 1977-78 that is very close to the survey estimate. However, no firm judgment can be reached about the level of fertility in 1977-78 because the types of data available so far are inadequate for that purpose.

Since total fertility rates derived from the trend of crude birth rates stand up well when compared with survey-based estimates, both the crude birth rates and derived total fertility rates may be considered as broadly confirmed for the decade from roughly 1965 to 1975.

NATIONAL TRENDS IN MARITAL FERTILITY, 1935-75

It can be assumed that virtually all births in Turkey are legitimate. That being so, all Turkish fertility is fertility within marriage, for which an appropriate measure of trends would be an index of marital fertility. The changing shape (age distribution) of marital fertility has been discussed in the preceding section. In addition, it is useful to measure the level of marital fertility and its trend.

Index of Marital Fertility

A suitable index of marital fertility is total marital fertility (TMF), defined as $\sum \underline{g}(\underline{a})$, where $\underline{g}(\underline{a})$ is the age-specific marital fertility rate for the ages, $\underline{a}$, of reproduction. TMF measures the average number of births women would have if they lived in a continuously married state from age 15 through 49. Since few women are married so early for an uninterrupted 35 years, total marital fertility is not actually achieved by the average woman. Nevertheless, it shows the level of fertility taking place within marriage. The index changes as the interplay of natural controls (e.g., breastfeeding) and voluntary controls (e.g., contraception) affect marital fertility.

The index is estimated below, but first it is necessary to estimate an index for marriage, which provides a convenient intermediate factor for the computation and is of interest in itself.

Index of Proportions Married

The difference between total marital fertility (TMF) and the total fertility rate (TFR), which is necessarily lower, is due to women spending part of their reproductive years unmarried. The greater the extent of non-marriage during these years, weighted by potential childbearing, the greater the difference between TMF and TFR. An index of proportions married, C_m, captures this factor (Bongaarts, 1978):

$$C_m = \frac{\sum m(a)g(a)}{\sum g(a)}$$

where m(a) is the schedule of proportions married by age a and the other terms are as above. When all women are married at all ages from 15 through 49, the value of the index is one; when none are married, it is zero. Since the schedule for marital fertility, g(a), is simply a weighting device, standard schedules of marital fertility are suitable. A changing age-pattern of marital fertility based on the rotation assumption (see above) was used to calculate the index, together with the information on proportions married given in Table 5.

Relationships Among the Indexes

So long as there are no births outside marriage, the marriage index is a direct link between TMF and TFR, that is: TFR = C_m (TMF). This relationship allows TMF to be estimated when the other two variables are already known, as in the present instance. The results for all three indexes are presented in Table 7. (See also Figure 12).

Factoring the total fertility rate into its two components, marriage and marital fertility, shows how the decline of total fertility came about. Although exact dating of turning points is impossible with the data at hand, the decline in marital fertility appears to have begun around 1950. Proportions married, however, were rising at that time and continued to rise for perhaps a half or full decade. By around 1960, though, the marriage index also began to decline. Because of later

TABLE 7 National Fertility Indexes, 1935-75: Turkey

Period	Total Fertility Rate (TFR)	Index of Marriage (C_m)	Total Marital Fertility (TMF)
1935-40	6.66	.747	8.92
1940-45	6.55	.753	8.70
1945-50	6.85	.766	8.94
1950-55	6.85	.784	8.74
1955-60	6.54	.793	8.25
1960-65	6.10	.782	7.81
1965-70	5.63	.764	7.37
1970-75	5.05	.740	6.82

timing in the marriage turnabout, the decline of total fertility did not get securely under way until about the mid-1950s.

The table below shows the approximate relative contribution of the two factors to the decline of total fertility.

	TFR	C_m	TMF
1950-55	6.85	.784	8.74
1970-75	5.05	.740	6.82
Annual percentage rate of decline	1.52	0.29	1.24
Relative contribution to the decline in TFR	100%	19%	81%

The stronger contribution of changes in marital fertility, accounting for 81 percent of the decline in total fertility, suggests that voluntary control of fertility within marriage has been more important than the reduction in the prevalence of a married state during the reproductive ages. Nevertheless, the marital status of the female population remains an important factor. It accounted for 19 percent of the decline up to 1970-75, and the currently high marriage proportions make it a potential factor for future change.

Marriage Trends

Sustained fertility decline is typically the outcome of changes in demographic behavior that occur earlier in time. This is true of the impact of marital status on fertility in Turkey. Whenever the age of first marriage changes, some years pass before the change in number of newly married women moves through the initial ages of childbearing and has its full impact. In Turkey, the time lag is not much more than the period to the next census (five years), because almost all Turkish women have married by their mid-20s in any event.

The mean age of first marriage for different cohorts, shown in Table 8, was calculated by the Hajnal method

TABLE 8 National Number of Women Ever Married, per 1,000 Women by Cohorts, and Mean Age of First Marriage (SMAM), 1930-35 to 1970-75: Turkey

Age Group	1930-1935	1935-1940	1940-1945	1945-1950	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975
	Cohorts Identified by Period When Age 15 Attained								
15-19	237	[a]	265	318	403	339	277	251	216
20-24	[a]	812	836	862	851	838	804	738	--
25-29	941	945[b]	933	958	956	946	932	--	--
30-34	969[b]	951	976	978	976	966	--	--	--
35-39	973	980	982	984	979	--	--	--	--
40-44	985	984	985	979	--	--	--	--	--
45-49	984	985	983	--	--	--	--	--	--
SMAM	20.0	19.9	19.6	19.1	18.8	19.2	19.8	20.2	20.8[c]

Note: In instances in which data were not available for the cohort's entire history, SMAM was calculated by fitting a standard marriage schedule (Coale, 1971) to the available data.

[a] The 1940 census does not provide information on marital status.

[b] Data for a ten-year age group in the 1950 census were split.

[c] The SMAM for the 1970-75 cohort is a preliminary estimate based on the assumption that the past association between SMAM and the proportion of ever married among women aged 15-19 (as expressed by a fitted curve) continues to prevail.

(see Hajnal, 1953, and singulate mean age of marriage in glossary). Cohorts of women are identified by the periods during which they pass the age of 15. Thus, women aged 15-19 in a census all entered marriageable ages during the preceding five-year period.

The use of five-year age groups and the effect of age misreporting in the census (Yener, 1969) biases the estimates of SMAM upward; however, the error would be at most half a year. Because the error is a systematic one due to stable features of the underlying data, these SMAM estimates can be used as a satisfactory indicator of trends. Data from surveys of married women that ask the age at which the women were first married were not used to estimate average age of first marriage. Recall error is present in data of this type, and there is a selection factor (only women already married are interviewed) that seriously biases the estimate downward. Neither of these forms of error exists in the census-type data to which the Hajnal method was applied.

Figure 9 illustrates the lagged effect on proportions married of new cohorts coming along with higher or lower mean ages of first marriage. The inverse relationship holds for both downward and upward movements of the SMAM. It can safely be predicted, therefore, that the continuing increase in the SMAM for the cohort entering marriageable ages in 1970-75 will cause a further decrease in the index of marriage in 1975-80.

One consistent upward pressure on the marriage index during the entire period from 1935 to 1975 was a decline in widowhood. This force is now largely spent, because widowhood within the main reproductive years has fallen to near negligible levels. In 1935, 39 percent of women at the end of the reproductive period (age 50) had been widowed without remarrying; in 1975, this proportion was down to 12 percent. The main cause of this change has been the rising expectation of life of husbands.

A good way to measure the effect of changing widowhood on the index of proportions married, C_m, is to calculate an analagous index for widowhood, C_w by substituting values of w(a) for m(a) in the definition of C_m, where w is the proportion widowed. These calculations yield the following results:

Index	1935-40	1955-60	1970-75
C_m (proportions married)	.747	.793	.740
C_w (proportions widowed)	.047	.020	.012

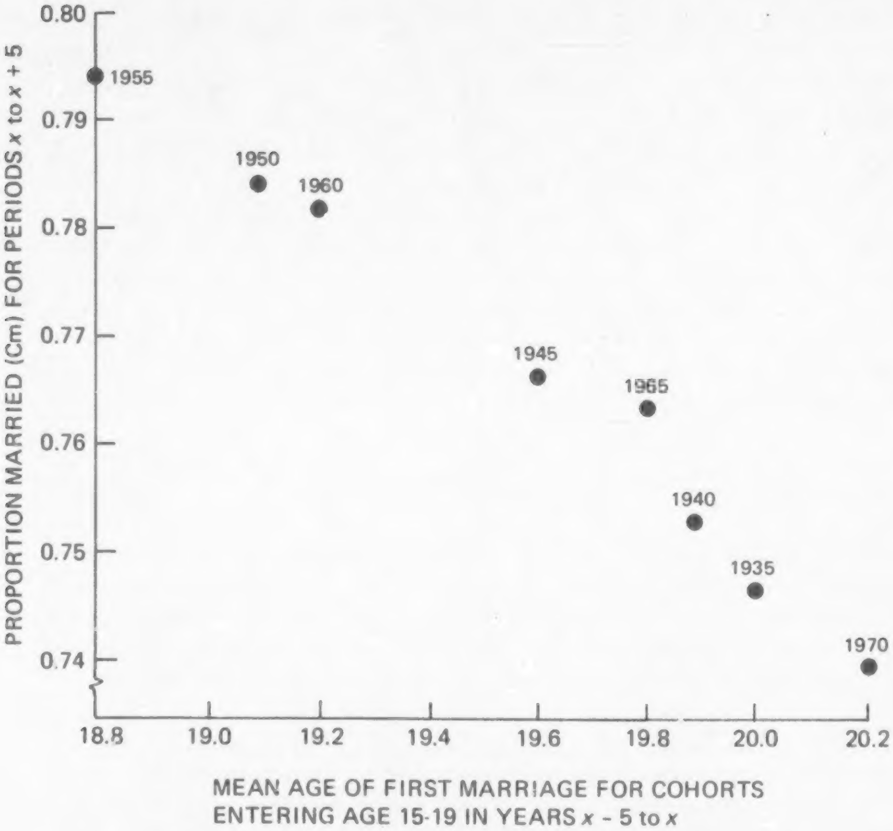


FIGURE 9 National Mean Age of First Marriage for Cohorts and Current Index of Proportion Married (C_m), 1935-75: Turkey

Note: For each point, the date x is shown. As an example, the point labeled 1955 plots the value of C_m for 1955-60 against the value of SMAM for the cohort entering marriageable ages 1950-1955.

When the index of proportions married was rising from 1935-40 to 1955-60, the main factor responsible was declining widowhood (which accounts for more than half the change), not a declining age of marriage although marriage was occuring earlier. During this period, irregularities of the age and sex structure were working themselves out, and economic conditions in agriculture improved, leading to earlier marriage. Nevertheless, the most important indirect influence on fertility was the reduction of death rates, because it reduced widowhood among women.

FERTILITY BY DIVISIONS OF THE POPULATION, 1945-68

The history of the fertility plateau and the subsequent decline of fertility in Turkey can be enriched by examining trends in subdivisions of the population. Data for this purpose are not as abundant nor as tractable by robust methods of estimation as the national data, so the same degree of precision cannot be claimed for divisional as for national estimates. Nevertheless, the broad outlines that can be documented are sufficiently unusual when compared with the demographic history of other countries to constitute a valuable addition to information about Turkey.

Divisions of the Population

The classic method of defining subpopulations in censuses is by the administrative divisions of the country. While subdivisions along socioeconomic dimensions would probably be more illuminating for the analysis of fertility differentials and changes, census and survey reports typically do not exploit this potential. However, a modest socioeconomic dimension can be introduced by making an urban-rural distinction. The number of divisions that can be defined is limited by the sample size of the surveys that are used at certain points in the estimation process. The six divisions finally demarcated, three urban and three rural, are shown in Figure 10.

The cities of Istanbul and Izmir were combined in a single division in order to create a sample size large enough for estimating the mortality parameters that are used for indirect estimation. Studies of fertility at the level of individual cities, conducted in 1966-67 by the Turkish Demographic Surveys, show that Ankara had substantially higher fertility than either Istanbul or Izmir, which were similar to each other (Turkey, School of Public Health, 1970). Because the robustness of divisional estimates is increased by aggregation, considerable use is made below of a three-division urban-rural grouping in which the rank order is (1) Istanbul and Izmir cities, (2) other urban (populations of 10,000 and over), and (3) rural (populations under 10,000).

For the divisional estimates of fertility, census information at a provincial rural-urban level was

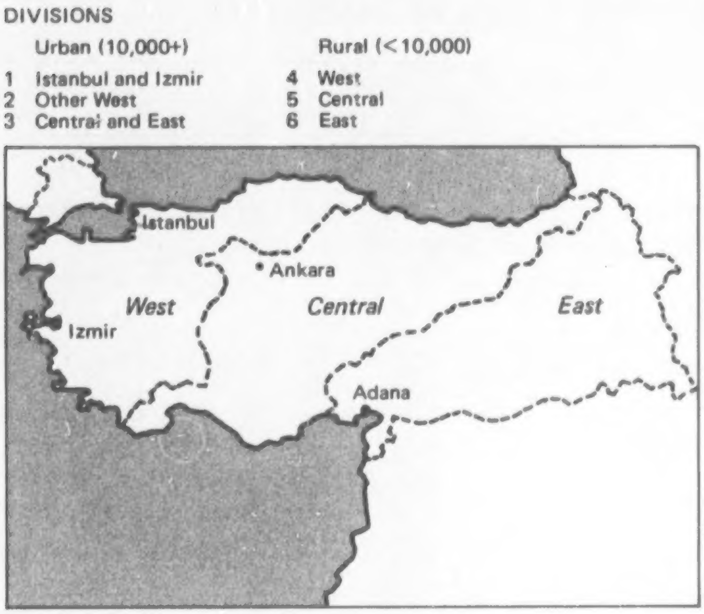

DIVISIONS
Urban (10,000+)
Rural (<10,000)
1 Istanbul and Izmir
2 Other West
3 Central and East
4 West
5 Central
6 East
Istanbul
Ankara
West
Central
East
Izmir
Adana

FIGURE 10 Urban-Rural and Regional Divisions of Turkey

aggregated into six divisions (combined for some purposes into three divisions) for the six censuses from 1945 to 1970. Table 9 presents a summary of population size and growth by divisions, which is based on these aggregations. The results of the aggregations are given in full detail in Appendix E (Table E-1). The other key element in the procedure for indirect estimation of fertility is information on infant and early childhood mortality by divisions, which is drawn from estimates described in Chapter 3.

Estimating Crude Birth Rates

The crude birth rate has been estimated using a method that depends upon an age distribution from a single census and child mortality for the period immediately preceding the census (U.N., 1967). The first step in the method is to choose a model life table on the basis of the child mortality information. Tabulated stable populations based on the selected life table are then used to look up the birth rate associated with a population proportion under age 10. This is an efficient

TABLE 9 Population Size and Growth by Six Divisions, 1945-70: Turkey

	Census					
Population Unit	1945	1950	1955	1960	1965	1970
Part A. Population Size (in millions)						
National	18.8	20.9	24.1	27.8	31.4	35.6
Urban						
Istanbul-Izmir	1.06	1.21	1.57	1.83	2.15	2.77
Other West	.93	1.08	1.45	2.16	2.78	3.74
Central and East	1.45	1.61	2.37	3.28	4.41	6.21
Subtotal	3.44	3.90	5.39	7.27	9.34	12.72
Rural						
West	6.22	6.68	7.24	7.76	8.17	8.28
Central	5.47	6.12	6.67	7.39	7.99	8.26
East	3.66	4.25	4.77	5.34	5.89	6.33
Subtotal	15.35	17.05	18.68	20.49	22.05	22.87
Part B. Percentage of Total Population						
Urban						
Istanbul-Izmir	5.6	5.8	6.5	6.6	6.9	7.8
Other West	5.0	5.1	6.0	7.8	8.9	10.5
Central and East	7.7	7.7	9.9	11.8	14.0	17.4
Subtotal	18.3	18.6	22.4	26.2	29.8	35.7
Rural						
West	33.1	31.9	30.1	28.0	26.0	23.3
Central	29.1	29.2	27.7	26.6	25.5	23.2
East	19.5	20.3	19.8	19.2	18.8	17.8
Subtotal	81.7	81.4	77.6	73.8	70.2	64.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

and only trivially biased method for making reverse projections over a short period of time. Turkish mortality has a strongly deviant age pattern (see Chapter 3) which imparts a slight downward bias to the birth rate estimated by this method.

The proportion of the population under age 10 is used, rather than some other index of the age distribution, because age misreporting under age 10 causes over- and understatements at different ages, which are largely offsetting. Using age 5 as the upper limit would give proportions that were too low. Data on porportions under age 10 are taken from Appendix E, Table E-1. Infant mortality estimates for approximately three years before each census are the estimates made below in the chapter on mortality (see Table 20 for rural and 23 for urban). A small amount of extrapolation of the mortality series before 1945 and after 1967 was necessary to provide appropriately dated mortality assumptions for the earliest and latest censuses (1945 and 1970, respectively).

The crude birth rate was then estimated for periods centered at five-year intervals, approximately 1943, 1948, . . . 1968. To emphasize that these are estimates of the birth rate for a period of time before the census date, which cannot be dated precisely, and to avoid having to make any assumptions about the special circumstances of the 1940-45 World War period, the initial series of estimates of the birth rate were treated as preliminary. Pairs of estimates for successive periods were then averaged. For example, the estimates for about 1940-45 (centered on 1943) and for 1945-50 (centered on 1948) were averaged to obtain an estimate corresponding approximately with the census of 1945, which is exact year 1945.8. Thus, a series of crude birth rates by divisions was produced for the census years 1945, 1950, . . . 1965, followed by an estimate for 1968 that is dependent on the single census of 1970.

Table 10 presents, as an example, the computations for Istanbul and Izmir. A summary of the results for all divisions is shown in Table 11, together with a population-weighted mean for the nation. The national means are not expected to agree exactly with crude birth rates estimated earlier by multiple reverse projection (Table 2), because a different procedure is involved.

A possible source of error in making the divisional estimates of births is the effect of migration on the divisional age structures. The critical index of age structure used for indirect estimation is the proportion under age 10, denoted as C(10). If the proportions migrating above and below age 10 are similar, the amount of error is limited. Although migration is age-selective in favor of young adults in the working ages, it also includes children under age 10 as part of family migration, which tends to limit changes in the index C(10) due to migration. A study of the net balance of urbanward migration in Turkey shows that 30 percent of the total population of migrants from 1955 to 1965 was under age 10 (Tekce, 1974). This is somewhat below the C(10) value for the rural population (32 percent), and above that for the urban population (24 percent).

TABLE 10 Estimation of Crude Birth Rate for Istanbul and Izmir, 1945-68: Turkey

Census Information[a]			Infant Mortality		Preliminary CBR	Final CBR	
Exact Date of Census[b]	C(10) Female	C(10) Male	Exact Date of Estimate[b]	$_{1}q_{0}$ (Both Sexes)	(Per 1000)	Date of Estimate	(Per 1000)
1945.8	.1464	.1363	1943.0[c]	.166	17.42	1945	18.7
1950.8	.1657	.1576	1948.0	.152	19.92	1950	21.0
1955.8	.1896	.1698	1953.0	.138	22.14	1955	22.5
1960.8	.1977	.1772	1958.0	.123	22.79	1960	22.9
1965.8	.2005	.1837	1963.0	.110	23.06	1965	22.8
1970.8	.2014	.1824	1968.0[c]	.096	22.62	1968	22.6[d]

[a] From Appendix E, Table E-1.

[b] Decimals indicate the exact date of the census or estimate to the nearest one-tenth year. For example, the 1965 and 1970 censuses in Turkey were conducted on 24 October and 25 October, respectively. The dates 1943.0, 1948.0, etc. refer to the beginning of each indicated year.

[c] Extrapolated from nearest date.

[d] For all dates except 1968, estimates are based on information from two censuses. The estimate for 1968 depends on the census of 1970 only.

Migration has little effect on estimates of the crude birth rate for the rural population, because the amount of migration is small relative to the total base population. However, migration does produce some upward bias in estimates of the urban crude birth rate.

Another possible source of error is variations in age misreporting from census to census which could upset the choice of C(10) as a good measure of population structure. Because of these sources of error, one must be wary in drawing conclusions beyond noting the main differentials and trends.

TABLE 11 Estimated Crude Birth Rates by Six Divisions, 1945-68: (per thousand population): Turkey

Approximate Date of Estimate	Urban			Rural			National[a]
	Istanbul and Izmir	Other West	Central and East	West	Central	East	
1945	18.7	26.0	32.8	39.2	56.5	56.0	45.2
1950	21.0	28.5	35.0	40.6	55.5	57.4	46.2
1955	22.5	29.8	36.8	42.2	55.0	59.8	46.7
1960	22.9	29.7	37.5	41.0	51.4	58.2	44.6
1965	22.8	28.9	37.0	38.5	48.9	56.2	42.3
1968	22.6	28.7	36.4	37.1	47.8	55.3	40.7

[a] Population-weighted mean of the separate divisional estimates.

The Turkish Demographic Survey provides some independent estimates of urban and rural birth rates for 1966-67. When the TDS estimates for Istanbul and Izmir in that year are combined, they give an estimated CBR of 24.3 births per thousand (Turkey, School of Public Health, 1970). This is slightly higher than the estimate of 22.7 per thousand for approximately the same date, interpolated from Table 11. The TDS estimate of the rural birth rate is 43.9 per thousand for a slightly different definition of rural, lower than the combined rural estimate of 46.5 interpolated for the same date from Table 11. Thus, the spread of birth rates between the divisions of the country is somewhat larger when estimated by the procedures used here than by those of the Turkish Demographic Survey. These differences, while not very great, underline the importance of accepting only the broad outlines of results rather than their specific details, especially where errors of this magnitude could upset conclusions.

Various Fertility and Marriage Indexes

Once crude birth rates are known by divisions, the same procedures used to derive the various national fertility and marriage indexes may be applied to divisional data. The principal additional data requirements for these calculations are proportions of women married by age and standard distributions for marital fertility, both shown in Table 12. The marital fertility schedules in Figure 11 show the characteristic differences between a rural population using relatively little fertility control and urban populations exercising greater control.

The additional measures of fertility and marriage shown in Figure 12 and Table 13 reveal that urban-rural differentials have persisted in Turkey for some time, probably going further back in history than can be measured with available data. There appears to have been some narrowing over the period covered here, due to both a slight rise in urban fertility and a decline in rural fertility. This rise in urban fertility since 1945 is a genuine finding; it is not a statistical artifact connected with the definitions of rural and urban. During this period the urban population's age of first marriage and the prevalence of widowhood fell. In addition, strong streams of migration to the cities of more people with rural origins probably tended to raise the average level of urban fertility (see Table 14).

TABLE 12 Proportions Married Females by Divisions of the Population, 1945-68 and Standard Marital Fertility Schedule: Turkey

Age Group	Proportions Married						Marital Fertility[c] (percent)
	1940[a]	1950[a]	1955	1960	1965	1968[b]	
Istanbul and Izmir							
15-19	.143	.186	.232	.201	.192	.201	17.1
20-24	.503	.570	.647	.661	.653	.660	30.5
25-29	.680	.740	.785	.819	.843	.840	25.4
30-34	.778	.794	.830	.857	.881	.892	15.8
35-39	.780	.803	.814	.850	.869	.879	8.4
40-44	.733	.779	.797	.816	.834	.848	2.2
45-49	.662	.642	.730	.771	.775	.780	.5
Other Urban							
15-19	.199	.241	.305	.276	.238	.232	21.6
20-24	.728	.757	.781	.791	.776	.763	29.3
25-29	.884	.886	.887	.910	.916	.913	22.1
30-34	.913	.914	.915	.928	.939	.940	12.8
35-39	.886	.895	.903	.918	.926	.932	9.6
40-44	.820	.840	.861	.876	.891	.897	3.9
45-49	.738	.769	.800	.829	.837	.846	.7
Rural							
15-19	.277	.336	.425	.360	.294	.279	19.6
20-24	.816	.849	.876	.867	.864	.848	23.6
25-29	.926	.928	.929	.959	.958	.953	20.4
30-34	.920	.921	.922	.959	.966	.964	17.7
35-39	.906	.916	.924	.947	.953	.954	13.2
40-44	.839	.860	.881	.904	.917	.922	4.6
45-49	.773	.805	.838	.873	.879	.886	1.0

[a] With the exception of Istanbul and Izmir, for which separate census data are available, estimates for 1945 and 1950 are based on the assumption that proportions married changed in each age group in each division from 1945 to 1955 in the same proportions as they changed in the national population.

[b] Based on interpolation between 1965 and 1970.

[c] From 1963 National Population Survey.

A by-product of the fertility estimates by divisions of the population is information on the number of annual births. In 1945, 90 percent of births in Turkey were rural; by 1968, the proportion was 75 percent. The quantity of rural births is no longer increasing and will almost certainly decline, while that of urban births is on the increase. Further increases in urban births are firmly indicated by the underlying demographic structure and trends.

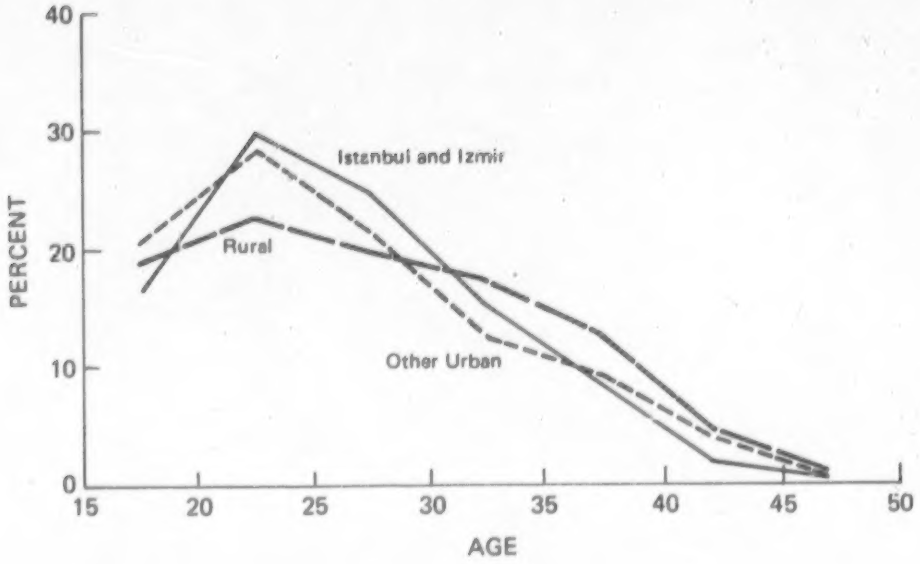


FIGURE 11 Distribution of Marital Fertility by Age, from 1963 National Population Survey: Turkey

Fertility by Province

A striking characteristic of social and economic data for Turkey is the large size of the differentials by province. There are 67 administrative provinces, and a great deal of information is compiled on this basis. The spatial distribution of characteristics blurs the possibly more important rural-urban differences but is nevertheless valuable when used in conjunction with other data.

By utilizing special tabulations of the 1965 census, it is possible to estimate fertility by province for a reference date around 1960. Information on place of birth for the population under age 10 was used to assemble the data by province of birth, thus controlling for the effect of migration on indirect estimates of births. The crude birth rate can then be estimated by province according to the following equation:

$$\text{CBR} = \frac{\text{Yearly Births}}{\text{Mid-period Population}} = \frac{P(0\text{-}9)/{}_{10}L_0}{P(\text{Tot})}$$

where P(0-9) refers to the population under age 10 born in the province and surviving at the time of the 1965

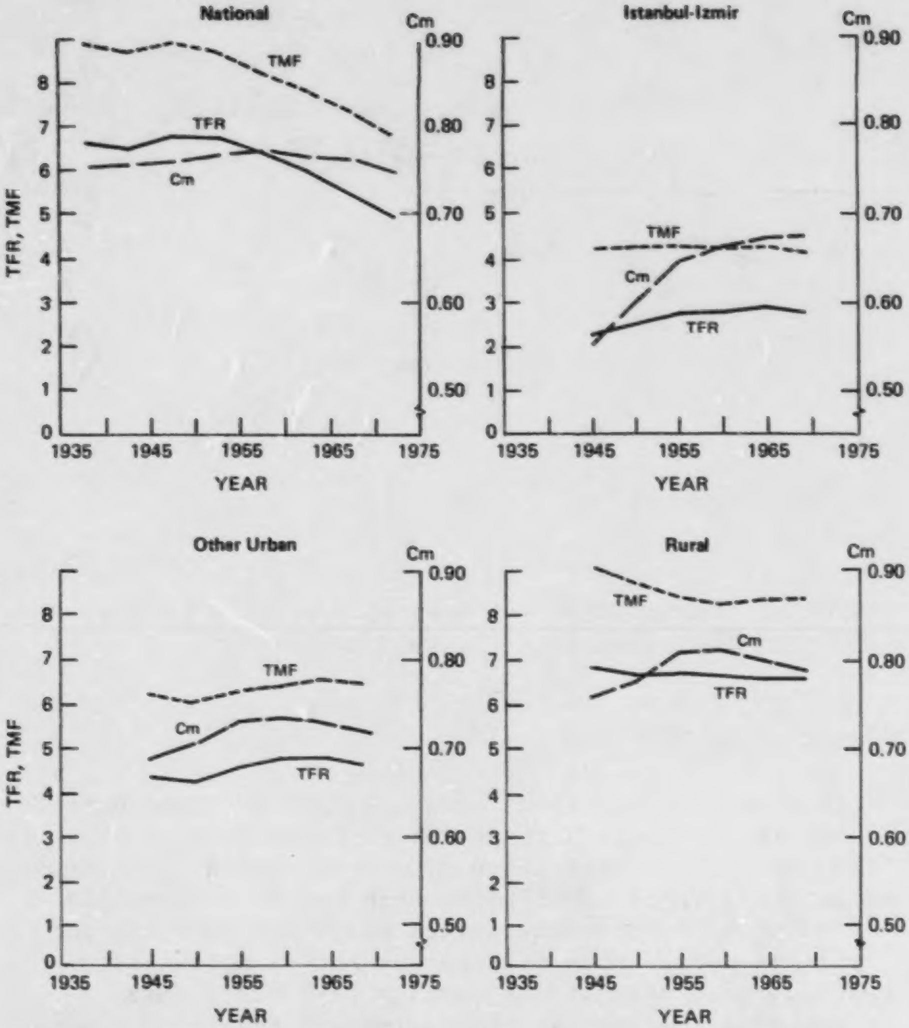


FIGURE 12 Fertility Measures and Marriage Indexes, 1935-75: Turkey

census enumeration. This population of survivors is divided by the person-years lived in a suitable life-table between birth and age 10 using a radix of 1.0. The resulting numerator is an estimate of average annual births for the province over the preceding 10 years. The denominator is the total population enumerated in the province five years earlier, in 1960.

Total fertility rates can also be calculated by choosing standard age-specific fertility distributions

TABLE 13 Fertility and Marriage Indexes by Divisions, 1945-68: Turkey

	Fertility and Mortality Indexes					First Marriage Indexes	
Date	CBR	Births (000s)	TFR	C_m	TMF	Proportion Single (15-19)	SMAM[a]
Istanbul-Izmir							
1945	18.7	20	2.41	.558	4.32	.851	22.4
1950	21.0	25	2.65	.607	4.37	.808	21.5
1955	22.5	35	2.91	.657	4.43	.761	20.8
1960	22.9	42	2.96	.673	4.40	.792	21.1
1965	22.8	49	3.04	.681	4.46	.804	21.0
1968	22.6	55	2.99	.686	4.36	.785	21.1
Other Urban							
1945	30.1	72	4.36	.691	6.31	.796	20.6
1950	32.4	87	4.31	.711	6.06	.754	20.1
1955	34.2	131	4.60	.734	6.27	.690	19.6
1960	34.4	187	4.72	.759	6.39	.719	19.9
1965	33.9	243	4.78	.731	6.54	.759	20.2
1968	33.5	281	4.70	.726	6.47	.772	20.5
Rural							
1945	49.4	758	6.99	.765	9.14	.718	19.5
1950	50.1	855	6.84	.787	8.69	.659	18.9
1955	51.3	957	6.86	.814	8.43	.568	18.5
1960	49.2	1009	6.82	.816	8.36	.635	18.9
1965	47.0	1036	6.78	.805	8.42	.703	19.5
1968	45.9	1028	6.73	.797	8.44	.736	19.8

[a] SMAM refers to the cohort passing age 15 during the five years preceding the date shown. Estimates of SMAM have an upward bias of up to one-half year (see text for further discussion).

based on TDS data and following the procedures described above for estimating divisional and national total fertility. The results are shown in Figure 13.

For the production of these estimates mortality assumptions in terms of $_{10}L_0$ from the Turkish Demographic Survey for 1966-67 were accepted. They refer to five regions and separately to Istanbul, Izmir, and Ankara cities. They were scaled so that the computed national birth rate would equal an estimate of the 1960 national birth rate of 45 births per thousand population. These mortality assumptions by TDS regions do not capture the finer detail of province-by-province differences in child mortality. The sensitivity of estimates of births to error in the mortality assumptions can be judged by making the extreme assumption of western Turkish mortality for the east of the country. In that event, the estimate of the total fertility rate for Hakkari province in the southeast corner of Turkey would be reduced from 10.6 to 9.5 children per woman indicating rather limited sensitivity.

TABLE 14 Components of Urban Population Growth, 1945-70: Turkey

Component	1945-1950	1950-1955	1955-1960	1960-1965	1965-1970	Total (millions)
	(Thousands)					
Total Increase	459	1,491	1,882	2,072	3,381	9.3
Births	510	695	988	1,303	1,680	5.2
Deaths	-329	-374	-454	-527	-600	-2.3
Natural increase	181	321	534	776	1,080	2.9
Reclassification	50	210	330	390	650	1.6
Migration	228	960	1,018	906	1,651	4.8
International	14	56	54	-121	-201	-0.2
Internal	214	904	964	1,027	1,852	5.0
Annual Percentage Growth Rate	2.5	6.5	6.0	5.0	6.2	

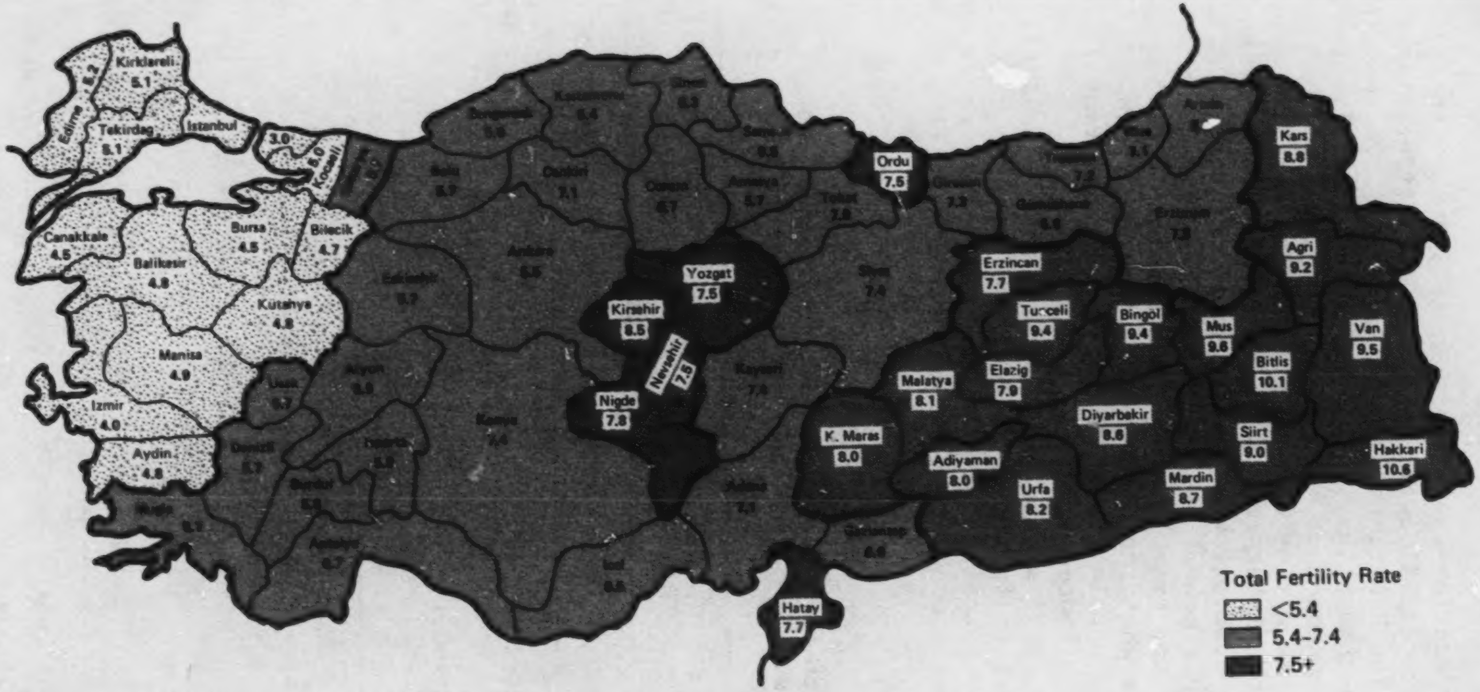
Note: This table is based on Tekce's (1974) chapter on the components of urban population growth from 1935 to 1970. The most problematic estimates are the allocations of international migration to the urban or rural populations. For 1945-60, Tekce divided international migration into urban and rural destinations on the basis of information about resettlement locations in Turkey for immigrant Turks; for 1960-75, she used reports of the worker recruitment services to divide into urban and rural origins.

Tekce's estimates of the components of urban growth are revised here by using birth rates from the present report. Her death rate is the TDS estimate for 1966-67 (11 per thousand) extended backward in time by linear interpolation to an assumed value of 18 per thousand during 1945-50. The assumed decline in the death rate was less steep in urban than rural Turkey, consistent with the estimates in Figure 4. The net balance of internal rural-to-urban migration is an unknown in the overall balance equation for each period and is therefore estimated as a residual. Errors in other components affect the internal migration estimate.

Variations in age misreporting, child mortality within regions of the TDS, and census coverage between 1960 and 1965 are all possible sources of error in provincial estimates. Nevertheless, the broad tendencies of the results by province are probably valid and are a valuable complement to other social data at the provincial level, such as infant mortality (see Table 24).

Fertility by Social Class

Although a classification of the whole population by socioeconomic groups is not feasible, some information is available about differences along this dimension. Using



Kirklareli
5.1
Edirne
5.2
Tekirdag
5.1
Istanbul
3.0
5.0
Kocaeli
Canakkale
4.5
Bursa
4.5
Bilecik
4.7
Balikesir
4.8
Kutahya
4.8
Manisa
4.9
Izmir
4.0
Aydin
4.8
Yozgat
7.5
Kirsehir
8.5
Nevsehir
7.5
Nigde
7.8
Ordu
7.5
Erzincan
7.7
Tunceli
9.4
Bingöl
9.4
Mus
9.6
Kars
8.8
Agri
9.2
Van
9.5
Bitlis
10.1
Malatya
8.1
Elazig
7.9
Diyarbakir
8.6
K. Maras
8.0
Adiyaman
8.0
Urfa
8.2
Siirt
9.0
Mardin
8.7
Hakkari
10.6
Hatay
7.7
Total Fertility Rate
<5.4
5.4-7.4
7.5+

FIGURE 13 Total Fertility Rates by Province, 1960: Turkey

mother's education as an approximate index of social class, Timur (1974) estimated fertility differentials from the 1968 Hacettepe Survey (Table 15). These data suggest, although they do not prove conclusively, that relative expansion of the size of the lower socioeconomic groups in the cities does tend to raise fertility overall. Such a simple interpretation of the increase in urban fertility, however, would miss complex factors that lie outside the scope of the present work. It remains to be explained, for example, how urban fertility could cease to increase when the proportions of rural-origin, lower-class population in the cities has apparently continued to increase.

For the rural areas, Timur's data show very little differential in fertility by social class when class is measured by education of mothers. While this rules out a simple numeric connection between rural fertility trends

TABLE 15 Births by Education of Mother, Standardized by Duration of Marriage, from the 1968 Hacettepe Survey: Turkey

Educational Attainment	Three Largest Cities	Other Cities	Town	Village
Part A. Number of Children Ever Born per Married Women Under Age 45				
Illiterate	4.1	3.8	4.3	4.3
Some schooling	2.5	3.1	3.1	3.8
Primary (5 years)	2.6	2.7	2.6	3.2
Secondary (8 years)	1.9	2.9	[a]	[a]
Total	2.7	3.2	3.8	4.2
Part B. Proportionate Distribution (percentages)				
Illiterate	20	51	61	83
Some schooling	23	18	15	8
Primary (5 years)	33	26	21	9
Secondary (8 years)	24	5	[a]	[a]
Total	100	100	100	100

[a] Too few cases to make an estimate.

Source: Timur (1974).

and rural class structure at different dates, investigation of fertility differentials and trends by different rural social groups may nevertheless be a profitable line of inquiry (Özbay, 1978). This subject, however, lies, beyond the scope of the present work.

3 Mortality

NATIONAL INFANT AND EARLY CHILDHOOD MORTALITY, 1945-75

When trends of infant and early childhood mortality cannot be estimated accurately from vital registration data, which is the situation in Turkey, a common approach is indirect estimation. Numbers of births in the past and the survival status of those children logically imply measures of past infant and early childhood mortality levels. An indirect estimation procedure is developed to handle the Turkish data and used to estimate past trends. The results are then checked for segments of the entire period 1945-75 by comparison with other types of estimates. Life table information on the age pattern of mortality below age 5 is also presented.

Strategy of Estimation

Infant and early childhood mortality are estimated in Turkey by indirect methods because death registration data are incomplete and defective (see Chapter 1). Miroslav Macura (1975a and b) has developed an indirect method of estimating trends that uses the birth-survival histories contained in the pregnancy history material of national sample surveys. This method, described in detail in Appendix B, was applied to the birth-survival histories collected by the 1968 Hacettepe Survey, which is the only national survey that provides tabulations of the type required.

The trend revealed by the birth-survival history method was then checked at various dates by a second method of indirect estimation originally developed by William Brass (1968). The Brass method, as modified by

James Trussell (1975), uses information from a survey or census about the proportions of children born alive who have died up to the time of the survey or census. The information on births and deaths is cross-classified by the ages of the women bearing these children. A second variant of the method cross-classifies the information by the duration of marriage of the women. In both instances, the information about parity and child survival is sufficient to make robust estimates of child mortality that refer to dates several years before the survey or census. For Turkey, two surveys and two censuses contain the type of data needed to make these national point-in-time estimates of child mortality.

Finally, the Turkish Demographic Survey provides an estimate of infant and early childhood mortality for one year, 1966-67, based on direct enumeration of the death events. This estimate is useful as another check point for the national trend of childhood mortality.

Both the Macura and Brass methods of indirect estimation utilize model life tables in their procedures. Although general measures of child mortality, such as those expressed by the proportion dying by age 2 (${}_2q_0$), are not highly sensitive to the choice of a standard family of models for the estimation procedure, precision is increased when this choice is based on direct information about the age pattern of childhood mortality. The life-table index most often referenced in the analysis of child mortality is the infant mortality rate, ${}_1q_0$. Estimation of this particular index, as contrasted with ${}_2q_0$, is more sensitive to the choice of the model family. It is useful, therefore, to begin by presenting information that justifies the selection of the "East" family of model life tables for the Turkish case. Once satisfied on this point, it is permissible to refer to infant mortality rates as a shorthand description of the general level of infant and early childhood mortality.

Age Pattern of Mortality

Data of adequate quality on deaths by age and sex are available from two dual-record systems in Turkey: the nationwide Turkish Demographic Survey (TDS) of 1966-67 and a 1976 rural health project in Yozgat province. Additional data based on health service records are available from two rural areas: Etimesgut and Cubuk.

The TDS data were used to construct a national life table for 1966-67. This involved a preliminary adjustment of the data to take account of the dual-record omission rate. The TDS data make it possible to estimate omissions separately for births, deaths under age 1, and deaths at higher ages. The life table, shown in Table 16, was constructed from the original TDS data after including this adjustment for omissions.

Another national life table for 1966-67, apparently based on the same data, is available from the State Institute of Statistics (S.I.S.) (Turkey, State Institute of Statistics, 1971). However, since the methods used to adjust the data are not explained, it is not possible to evaluate this table fully. The S.I.S. statistics on infant mortality are the same as those in Table 16, but the mortality rates at higher ages are all lower. Apparently S.I.S. did not use the TDS omission rate to adjust deaths above age 1, with the result that the S.I.S. tables give slightly higher estimates of the expectation of life at birth: 1.0 years higher for males and 1.4 years higher for females.

The age pattern of mortality in Turkey up to age 5, as shown in Table 16, was compared with the four Coale-Demeny (1966) regional families of models (see glossary). This was done by selecting a model level from each family that exactly matches the infant mortality rate of the Turkish table. Figure 14 shows the four model levels that match the Turkish data on proportion of births surviving to age 1 (ℓ_1). Each of the four models predicts a proportion surviving to age 5 (ℓ_5), which is then compared with the Turkish life-table value. As shown, the "East" family gives the best representation of the Turkish childhood age pattern, with "West" being second best.

Further tests were carried out by making the same comparisons by sex, by rural-urban subdivision of the national population, and using the data from the three area studies mentioned above. The results are shown in Table 17. Up to age 5 the national life tables agree most closely with the "East" models. The Yozgat life table is also based on a dual-record system with a sample size similar to that of the TDS (50,000 persons). The Etimesgut and Cubuk life tables are least similar to the "East" models, but even for them the "East" models are the best available representation. The choice of "East" implicitly accepts the "East" pattern of heavy mortality under age 1 as compared with the next higher ages of early childhood. More information concerning the national age pattern of deaths below age 1 and between age 1 and 5 is not available.

Estimates Derived from Birth-Survival Histories

The Macura method for estimating trends in child mortality from birth-survival histories uses information on the date of each birth, survival status of each live-born child at the time of the survey, and the date of death of each child who died before the survey. Implicit in this information is a history of the child survival trends. The mothers alive at the time of the survey are accepted as a representative sample of mothers having children and experiencing child mortality in the past. The procedure is to select model life tables that could account for the levels of survivorship found at the time of the survey in the different birth cohorts of children reported by the mothers. (See Appendix B for a more detailed explanation of the procedure.)

To inspect the consistency of results going back in time from the 1968 survey to 1945, the procedures were applied separately to six subdivisions of the population and then aggregated to obtain the national results shown in Table 18. (The divisional estimates, which are useful for other purposes, are presented later.) When the data are disaggregated to the divisional level, there is sufficient consistency among them to justify accepting the national trend estimates as a valid independent series for childhood mortality. Their origin in a single set of data (the 1968 survey) that gives estimates for different dates all by the same method increases their credibility for trend analysis. Nevertheless, data errors and biases due to unfulfilled assumptions are possibilities, and these are elaborated in Appendix B. It is useful, therefore, to have additional evidence against which to check the results given by this method.

Estimates Derived by the Brass-Trussell Method

The estimation of child mortality from information collected in a census or survey on children ever born (CEB) and children surviving (CS) was first developed by Brass (1968), who calculated a table of multipliers for converting statistics on the proportion dead among CEB

TABLE 16 National Life Table, Based on One Year of Data Centered on February 1967: Turkey

Age(x)	q(x) (1,000)	d(x)	m(x) (1,000)	l(x)	L(x)	P(x)	T(x)	e(x)	Age(x)
Females									
0	143.8	14,380	159.6	100,000	90,077.8	.83914[a]	5,482,588.2	54.826	0
1	56.7	4,853	14.7	85,620	329,493.9	.95746[b]	5,392,510.4	62.982	1
5	10.5	846	2.1	80,767	401,722.1	.99083	5,063,016.4	62.687	5
10	7.9	628	1.6	79,922	398,037.5	.99084	4,661,294.3	58.323	10
15	10.5	830	2.1	79,293	394,391.4	.98798	4,263,256.8	53.766	15
20	13.6	1,066	2.7	78,463	389,650.2	.98538	3,868,865.5	49.318	20
25	15.7	1,212	3.2	77,397	383,953.1	.98356	3,479,215.3	44.953	25
30	17.2	1,312	3.5	76,184	377,642.1	.98099	3,095,262.2	40.629	30
35	20.8	1,560	4.2	74,872	370,462.0	.97712	2,717,620.1	36.297	35
40	25.0	1,830	5.1	73,312	361,987.5	.96874	2,347,158.1	32.016	40
45	37.7	2,697	7.7	71,483	350,671.3	.95707	1,985,170.7	27.771	45
50	48.3	3,325	9.9	68,786	335,617.4	.93670	1,634,499.4	23.762	50
55	79.0	5,173	16.5	65,461	314,372.5	.91034	1,298,882.0	19.842	55
60	101.2	6,102	21.3	60,288	286,185.3	.87462	984,509.5	16.330	60
65	152.3	8,251	33.0	54,186	251,304.4	.79480	698,324.2	12.887	65
70	267.7	12,295	61.8	45,935	198,940.8	.69610	448,019.8	9.753	70
75	353.4	11,889	85.9	33,641	138,481.8	.44402[c]	249,078.9	7.404	75
80	1,000.0	21,752	196.7	21,752	110,597.2	.0	110,597.2	5.084	80

Males									
0	162.0	16,200	183.1	100,000	88,498.0	.81978[a]	5,148,866.6	51.489	0
1	61.3	5,139	16.0	83,800	321,391.0	.95327[b]	5,060,368.6	60.386	1
5	13.1	1,028	2.6	78,661	390,733.8	.98926	4,738,977.5	60.246	5
10	8.4	651	1.7	77,633	386,536.3	.99110	4,348,243.8	56.010	10
15	9.4	726	1.9	76,982	383,095.0	.98669	3,961,707.5	51.463	15
20	17.2	1,313	3.5	76,256	377,997.9	.98329	3,578,612.5	46.929	20
25	16.2	1,213	3.3	74,943	371,682.8	.98253	3,200,614.7	42.707	25
30	18.9	1,384	3.8	73,730	365,190.4	.97944	2,828,931.9	38.369	30
35	22.4	1,619	4.5	72,346	357,681.8	.97330	2,463,741.4	34.055	35
40	31.1	2,200	6.3	70,727	348,133.2	.95819	2,106,059.7	29.777	40
45	52.8	3,621	10.9	68,527	333,579.5	.94472	1,757,926.4	25.653	45
50	57.8	3,754	11.9	64,905	315,140.7	.92600	1,424,346.9	21.945	50
55	91.1	5,574	19.1	61,151	291,821.6	.88191	1,109,206.2	18.139	55
60	147.7	8,211	31.9	55,578	257,360.5	.83849	817,384.6	14.707	60
65	177.7	8,415	39.0	47,367	215,795.3	.76674	560,024.2	11.823	65
70	300.9	11,720	70.8	38,951	165,458.4	.64415	244,228.8	8.837	70
75	434.5	11,831	111.0	27,232	106,580.7	.40381[c]	178,770.4	6.565	75
80	1,000.0	15,400	213.3	15,400	72,189.7	.0	72,189.7	4.688	80

[a] P(Birth).
[b] P(0-4).
[c] T(80)/T(75).

Source: Based on data from the 1966-67 Turkish Demographic Survey.

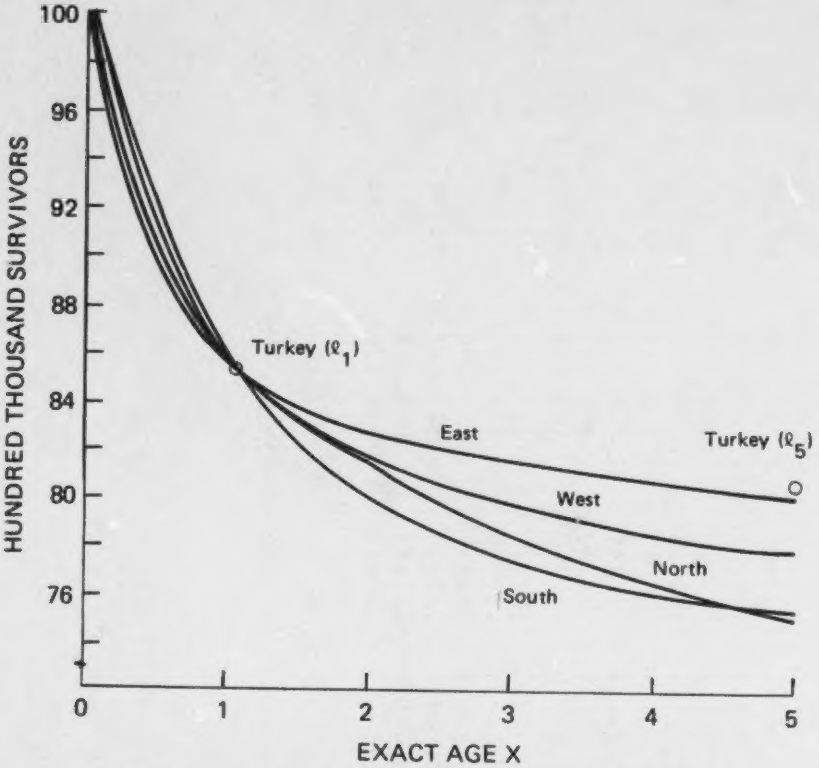


FIGURE 14 Survivors from a Cohort of 100,000 Female Births (ℓ_x). Four Regional Models with same Values for ℓ_1 for Demographic Survey Estimates, 1966-67: Turkey

reported by women in age groups 15-19, 20-24, 25-29, etc., into estimates of the probability of dying before reaching certain exact childhood ages. In conventional terminology D(i) denotes the proportion dead of CEB in successive five-year age groups, with i=1 indicating the age group 15-19, i=2 the age group 20-24, etc. In effect, the Brass multipliers convert D(i) values into estimates of q(x), where q(x) = 1 - l(x), the probability of dying between birth and exact age x.

Brass found that the relationship between corresponding pairs of D(i) and q(x) is primarily influenced by fertility patterns and, in particular, by the age at onset of childbearing. Therefore, the appropriate value of a conversion multiplier depends on the value of P(1)/P(2)--a good indicator of early fertility conditions--where P(i) is the average parity observed among women belonging to age group i. Brass evaluated

TABLE 17 Age Patterns of Early Childhood Mortality in Turkish Life Tables and in the "East" and "West" Families of Model Life Tables: Turkey

	Observed Proportion Surviving Up to		Proportion Surviving Up to Age 5 Predicted by	
Data Source and Population	Age 1	Age 5	"East" Models	"West" Models
TDS (1966-67)				
National females	.856	.808	.801	.777
National males	.838	.787	.788	.764
Rural, both sexes	.832	.773	.773	.749
Urban, both sexes	.887	.858	.852	.835
Yozgat (1976)				
Females	.862	.818	.810	.787
Males	.860	.831	.818	.799
Etimesgut				
Both sexes, 1967-68	.865	.840	.821	.799
Both sexes, 1971-77	.904	.889	.876	.863
Cubuk (1977)				
Both sexes	.868	.844	.825	.804

Note: Data are presented for both sexes combined whenever the number of cases is too small to support separate estimates for each sex.

the appropriate multipliers by modeling fertility schedules as third-degree polynomials. Later, Sullivan (1972) computed another set of multipliers by using regression techniques applied to data obtained from observed fertility schedules. More recently, Trussell (1975) created a third set by the same means but using data generated from the model fertility schedules developed by Coale and Trussell (1974). Of the three sets, the Sullivan and Trussell multipliers are easier to apply. The Trussell multipliers were used in this report.

National data for Brass-type estimates are available from four sources: the 1963 survey of the Ministry of Health, the initial interviews in 1965 and 1966 of the Turkish Demographic Survey, and the censuses of 1970 and 1975. Although appropriate data were collected in the 1968 and 1973 Hacettepe surveys, they are not available. The age model was used for all four sources, because only one (the 1963 survey) contains data suitable for the marriage-duration method of estimation. Since the 1963 survey does not include information on the total number of women but only the number of married women in each age group, data on marital status from the censuses of 1960

TABLE 18 National Infant Mortality Rate, 1945-70: Turkey

Exact Reference Date[a]	Infant Mortality Rate ($_1q_0$) (Both Sexes)	Regrouped by Intercensal Periods	Infant Mortality Rate ($_1q_0$)
1945	274	1945-50	260
1947	270	1950-55	233
1949	255	1955-60	203
1951	245	1960-65	176
1953	235	1965-70	151[b]
1955	224		
1957	212		
1959	199		
1961	189		
1963	178		
1965	169		
1967	156		

[a] Exact reference dates are used for point-in-time dating of estimates. They refer to the exact beginning of the year if no decimal digits are shown.

[b] Extrapolated for second half of period.

Source: The single-date estimates are the result of applying the Macura birth-survival method to the 1968 Hacettepe survey data. The five-year estimates are averages for intercensal periods, from October of each census year to the next, matched to the dates of the multiple reverse projections shown in Table 2.

and 1965 were used to fill this gap in the basic data. Because the age model was used for data from all four sources, comparability of the estimation method is assured.

The Brass method provides an estimate of the child mortality experience of women of successively higher ages. Reliable estimates are usually obtained from women aged 20-24, 25-29, and 30-34. The results are expressed in terms of the infant mortality rate for each age group, using "East" models. When the infant mortality rate is falling, the estimates from women 25-29 should be higher than those from the younger women aged 20-24. The Turkish estimates, presented in Table 19, do not have this pattern; instead, data from women 25-29 yield lower estimates of child mortality than those from women 20-24. This pattern holds true in all four sources. Estimates from women aged 30-34 fall into no regular pattern.

Finding lower estimates of infant mortality associated with women of higher ages is logically acceptable only if the trend of infant mortality is upward. However, the

TABLE 19 Estimates of the National Infant Mortality Rate Based on Reports of Mothers at Different Ages, Four Sources: Turkey (Infant Deaths per Thousand Births)

	Age of Mothers Giving Reports				
Source of Data	20-24	25-29	30-34	Mean for Ages 20-29[a]	Reference Year
1963 survey	211	206	174	208	1960
1965-66 TDS	189	170	164	180	1963
1970 census	154	144	159	149	1967
1975 census	130	128	139	129	1972

[a] Rounding of the numbers that are averaged makes the means appear to contain small errors when they do not.

overall level of the Turkish estimates from each source declines with time. Hence, some form of systematic data error is present. There are various possible explanations.

One theory starts with the observation that women who have had none of their children die have more living children than other women of their same age and fertility. A tendency toward female age exaggeration in precisely the age ranges used for Brass-type estimates is noted elsewhere (see Appendix C on age misreporting). Thus, it is likely that the women with fewer (or no) child deaths, and hence more surviving children will be perceived as being older and will be misreported accordingly. Such selective transfer of women to higher age groups raises the infant mortality rate estimated from the 20-24 age group relative to that estimated from the 25-29 age group.

Another possible explanation is based on the fact that women of low socioeconomic status not only experience higher child mortality than women of higher status but they also marry earlier. Therefore, the women associated with high mortality are a greater proportion of the mothers in the 20-24 age group than in the next higher age group. Most Turkish women have married by their early 20s, so this type of selectivity cannot be very strong in the age group 20-24, but to the extent that it does exist it contributes to the puzzling reversal in the estimates.

Because of these systematic errors in the data, an average of the estimates for the 20-24 and 25-29 age groups is a stronger estimate of the level of childhood mortality than any one of the three available estimates taken alone. Mortality information provided by the women aged 30-34 was not included because the data errors appear to be less systematic from one source to the next.

The Brass-type estimates refer to an average of experience for a number of years preceding the survey date. The date on which this experience centers is calculated and comes to 3.1 or 3.2 years before the survey for the estimates made here (averaged over two age groups of women). For example, the last Turkish census was taken in October 1975; the child mortality estimate based on this census refers to a period centered on mid-1972.

The estimates of childhood mortality (based on the age

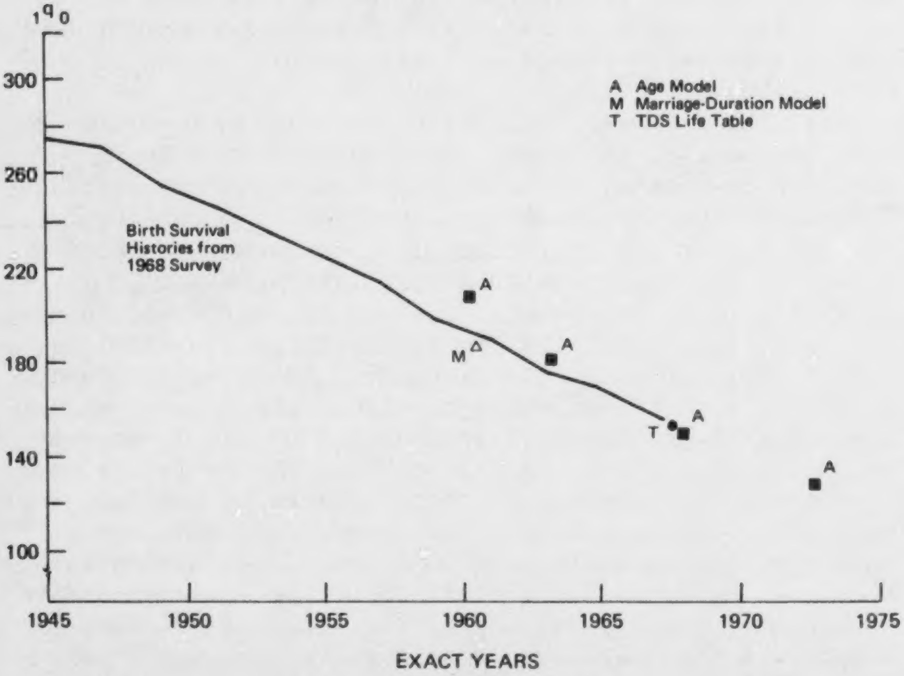


FIGURE 15 Early Childhood Mortality Expressed in Terms of Infant Mortality Rate, 1945-75 (per thousand): Turkey

Source: Tables 18 and 19.

model) are shown in Table 19 and plotted in Figure 15 together with the trend estimates derived from the birth-survival histories. Two points are plotted from the 1963 survey, both dated early 1960; the higher estimate is based on the Brass-Trussell age model and is comparable in terms of method of estimation with the other points shown as A. However, the basic data for the 1960 estimate were incomplete as explained earlier in this section. Fortunately, the 1963 national population survey contains data with which to bypass the problem. Tabulations were made of CEB and children who have died (CD) by the duration of marriage of women in the national sample. A variant of the Brass-Sullivan-Trussell method applies a marriage duration model to the data to reach an estimate of the infant mortality rate. The result is shown by the point M plotted in Figure 15. While this estimate is not comparable in method to the other points A, it is soundly based on a single sample of women (not mixed with census data), and may be interpreted as a lower-limit estimate for 1960.

Finally, the figure shows a single life-table estimate T of infant mortality from the TDS. Since this chart refers to mortality for both sexes combined, the infant mortality rates for each sex ($_1q_0$ in Table 16) are combined according to a sex ratio at birth of 105 males per 100 females. The resulting infant mortality rate of 153 per thousand is dated 1967.2 (the midpoint of the enumeration period).

Juxtaposing all these single-date estimates with the trend estimates strongly confirms the results of the Macura method of birth-survival histories for the period from 1960 to 1968. These favorable results create a presumption, although not complete assurance, that trend estimates for earlier dates derived by the same birth-survival method are also reliable. Going back as far as 1945 from 1968, the number of women old enough in 1968 to give reports diminishes, because the upper age limit for the survey was 45 years of age. Since these older women were having their first children at the early dates around 1945, and first-order children have higher risks of death than second and higher order children, the infant mortality experience reported by them is probably higher than for all children born during that early period. This could exert an upward bias on estimates at very early dates. No attempt was made to carry the trend back further than 1945.

Use of the Estimates in Multiple Reverse Projections

The child mortality trend estimates are important assumptions underlying the multiple reverse projection method described in Chapter 2. Since the projections are made by intercensal five-year periods, the necessary estimates are centered on exact between-census dates: 1938.3, 1943.3,...1973.3. For the period 1945-70 the centered estimates were computed from the trend shown in Table 18. For 1973.3, an estimate of 126 was obtained by extrapolation of less than one year from the Brass-Trussell estimate for 1972.7, which was based on the census of 1975. For years earlier than 1945, the assumptions for child mortality were derived from estimates of adult mortality by a procedure explained below in the section on general mortality.

INFANT AND EARLY CHILDHOOD MORTALITY BY DIVISIONS, 1945-67

The data and methods for examining differentials and trends in infant mortality by divisions are the same as those used for the national estimates. Since the data are mainly from surveys, although checked for some dates by census data, the material is less satisfactory for any single division than for the national estimates, due to the small numbers involved. In addition some special problems of interpretation that do not affect national estimates arise in the case of divisional estimates. The strategy of deriving divisional estimates, therefore, was to begin with preliminary estimates based on the birth-survival history method. These results were then checked against trends estimated from independent data by the Brass-Trussell method. Finally, a number of adjustments were made to handle the special problems that affect only the divisional estimates.

Preliminary Estimates

The estimates obtained by application of the birth-survival history method are shown without adjustment in Table 20. These estimates were compared with estimates derived by the Brass-Trussell method for the dates 1960, 1963, and 1967 by using values of the birth-survival estimates interpolated for the same dates.

TABLE 20 Estimates of Infant Mortality by Divisions,
1945-70: Turkey

	Urban (preliminary)			Rural		
Exact Reference Date[a]	Istanbul and Izmir	Other West	Central and East	West	Central	East
1945	190	216	252	227	344	280
1947	181	208	241	221	330	277
1949	175	200	231	218	315	266
1951	164	194	221	209	297	261
1953	158	187	209	205	278	254
1955	149	180	201	200	258	245
1957	140	172	191	194	230	236
1959	130	163	180	190	208	228
1961	124	157	169	186	191	222
1963	114	146	159	178	173	206
1965	108	142	149	172	164	187
1967	100	135	140	166	155	166

Note: The urban estimates are preliminary, because they require adjustment as explained in the text and in Table 23. The rural estimates are accepted as explained in the text.

[a] See footnote a, Table 18.

Source: Based on birth-survival histories of 1968 Hacettepe survey.

The comparison is made after grouping the birth-survival history estimates into the three urban-rural divisions shown in Table 21 and plotted in Figure 16. Without exception, the independent sources confirm the existence of substantial rural-urban differentials. The downward trends are confirmed over all segments of time except one, the 1960-63 period for Istanbul-Izmir. There is no explanation for this anomaly in the data other than the ever-present possibility of error affecting one of the two data sources. The downward trend for Istanbul-Izmir is firmly supported, however, by comparing either of the first two paired estimates (1960 or 1963) with the paired estimates for 1967, which are clearly lower. The slope of the downward trend for Istanbul-Izmir is left in some doubt.

The independent estimates of 1963 for "other urban" and rural reflect a division between urban and rural at a population size of 2,000 instead of the 10,000 used in all the other data sources. This classification of rural, small-town populations as urban probably raises

TABLE 21 Infant Mortality Rates by Divisions from Birth-Survival Histories (BSH) Compared with Brass-Trussell Estimates from Various Sources, 1960, 1963, 1967: Turkey

	1960			1963			1967		
Division	BSH	Survey of 1963	Date of Estimate	BSH	TDS	Date of Estimate	BSH[a]	Census of 1970	Date of Estimate
Istanbul and Izmir	126	122	1960.4	114	128	1963.1	98	104	1967.6
Other Urban	168	179	1960.3	154	175[b]	1963.3	135	141	1967.7
Rural	202	217	1960.2	185	184[b]	1963.0	158	157	1967.7
National[c]	194	208	1960.1	178	180	1963.1	151	149	1967.7

[a] Extrapolated for fraction of year.

[b] The TDS division between rural and urban is 2,000 persons, whereas 10,000 applies to all other sources above.

[c] Note that the dating of estimates by divisions varies. The national estimates differ slightly from theoretical averages, which are birth-weighted means. Estimates were made separately for divisions and for the national total.

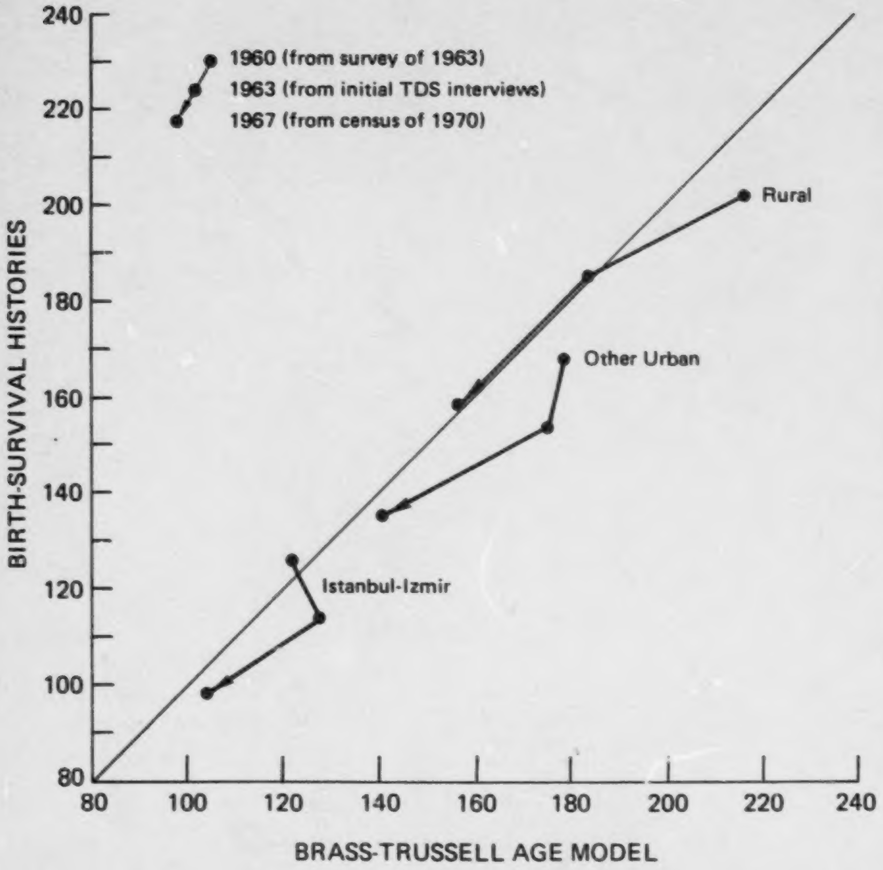


FIGURE 16 Comparison of Infant Mortality Estimates from Birth-Survival Histories with Independent Brass-Trussell Estimates by Rural-Urban Divisions (rates per thousand): Turkey

both the rural estimate of infant mortality and the "other urban" estimate. This could account for the leftward kink in the rural curve, but not the rightward kink in the "other urban" curve. Some error is evidently present in the data blurring the broad confirmation of trends.

Additional estimates for all six divisions were tested by the same procedure, and the results are shown in Figure 17. The effect of sampling error and other types of data error on estimates is bound to increase as smaller divisions are demarcated. For example, the independent estimates for "other urban west" show an

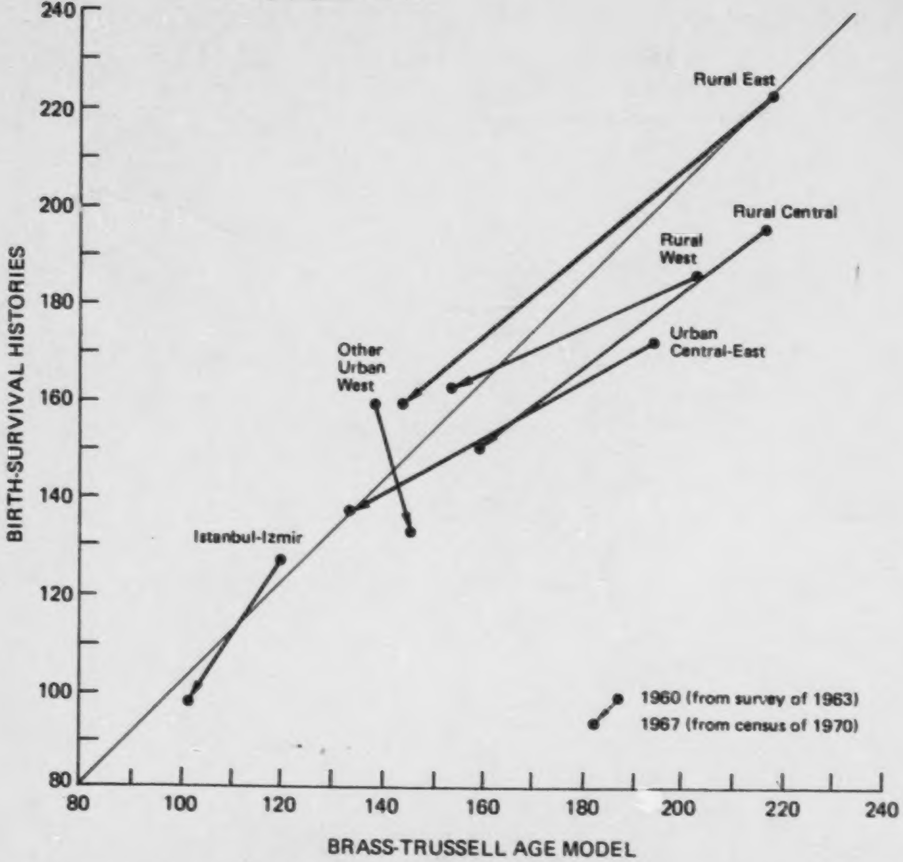


FIGURE 17 Comparison of Infant Mortality Estimates from Birth-Survival Histories with Independent Brass-Trussell Estimates by Regions within Rural and Urban Divisions (rates per thousand): Turkey

increase rather than a decline from 1960 to 1967. This raises a question about the direction of the trend; however, the consistent confirmation of downward trends in the other divisions argues for accepting the downward trend for "other urban west" as well. In all other respects, there is reasonable agreement among the estimates from the birth-survival histories and independent sources.

Data with which to make independent tests of the trends earlier than 1960 are not available. However, some value can be attached to the earlier estimates keeping in mind that divisional estimates are inherently less robust than national ones (sample size) and there remain some issues of interpretation to be discussed below. Furthermore, if the birth-survival histories are a reasonable basis for sketching the main outlines of mortality trends during the period for which they can be checked, they are likely to be valid for the earlier dates as well.

Adjusting for Rural Births and Deaths Reported by Urban Mothers

Measurement methods that look back in time from a survey carry with them the problem of allocating the births and deaths reported by mothers to the different divisions of the country. The mothers interviewed in 1968 are representative of mothers living in the divisions at that time; however some births and deaths of their children occur in different divisions if the mothers migrate after childbearing starts. In addition, some of the towns where the survey is conducted are urban at the time of the survey but were part of the rural division at an earlier date. These two circumstances create possibilities for measurement error that are discussed below. Neither type of error affects national estimates, because both involve allocating information about infant mortality between divisions, not its relevance to the country as a whole.

The Hacettepe tabulations of 1968 assign births and survival histories to the rural and urban divisions according to the mothers' place of residence in 1968. Tabulations for the independent Brass-Trussell estimates are also made in the same way in all sources. Thus, for example, the Ministry of Health's survey in 1963 (providing Brass-Trussell estimates for 1960) is tabulated according to residence in the rural and urban divisions of 1963.

Errors Due to Migration of Mothers

The first problem to take up, which applies equally to the birth-survival history method and the Brass-Trussell method, is the effect of rural-to-urban migration of mothers. Since the rural setting has higher infant mortality rates than the urban setting, the inclusion of rural birth-survival experience in the data for urban estimates causes an upward error for the urban division.

It is not clear whether omission of this rural mortality experience from the rural estimation procedure causes error in the rural division estimates as well. If the misallocated information refers to average rural experience, there will be no error in the rural estimate. If there is a difference, the practical effect is likely to be trivial, because the number of misallocated rural births is so small relative to total rural births in Turkey.

The likelihood of upward error in the urban estimates of infant mortality rests on three conditions that must all be present: higher rural than urban mortality rates, rural-to-urban migration by mothers, and pre-migration childbearing. All of these conditions are fulfilled in Turkey. It is necessary, therefore, to evaluate their importance in the Turkish setting during the period of estimation.

Some information on this point comes from a 1966 survey of women in Ankara city carried out by the Sociology Department of Middle East Technical University under the direction of David Goldberg. A well-designed representative sample of 803 women was interviewed. The survey occurred only two years prior to the 1968 survey that is the source of the birth-survival histories. The Ankara survey follows a decade of high rural-to-urban migration, about which more is said below. Adlakha (1970) makes use of migration information in the survey to divide the births by rural and urban settings. It is assumed that in most instances the mother did not bring the newborn child to the city immediately, so its survival experience during infancy and early childhood is assumed to belong to the setting of its birth.

Infant mortality rates are calculated in various ways, making it possible to isolate clearly the error that occurs when rural births are included in the urban data. For six years immediately preceding the Ankara survey, 8.5 percent of births were rural, leading to an infant mortality rate 5.0 percent higher than the "true" urban rate of 109 per thousand births. For an earlier period, 7 to 16 years preceding the survey (1950-59), the error is greater. Rural births were 27.3 percent of births reported for this period, and the infant mortality rate was 18.6 percent higher than the "true" urban rate of 133 per thousand births. In the Ankara study, "urban" was defined as the entire urban sector, not limited to Ankara city alone.

The higher degree of error for earlier dates is not intrinsic to the estimation procedure but is due to a different pattern of premigration childbearing at that time. As rural-to-urban migration picked up speed in Turkey, starting from modest levels in the 1940s (see Table 14) some women who had already started their childbearing migrated to the cities. During this period, women typically followed or joined their husbands in the city. In the 1960s, a new pattern was established wherein migrant women had all, or nearly all, of their children in the city after migration. This change was supported by a rising age of marriage for rural women and by the existence of more possibilities to marry "upward" to men who became established in ever increasing numbers in the cities. In addition, a second generation of "village" men became available as boys migrated in their teens to the homes of relatives in the cities and grew up there.

The Ankara study provides a standard by which to evaluate the error in mortality rates due to the rural-urban migration of mothers. Since migration is the cause of the error, migration rates for women aged 15-39 are a good indicator of the relative importance of the estimation error in different parts of the urban population. Detailed migration estimates by age and sex for Turkish cities are available for the decade 1955-65, a period that closely precedes the 1968 Hacettepe survey (Tekce, 1975). The female migration rate for ages 15-39 for Ankara was 61.5 per thousand annually, one of the highest city rates in Turkey, showing that the Ankara standard represents estimation error due to migration at its extreme. The general rate, for all cities over 10,000 population, was 25.9 per thousand. For Istanbul-Izmir and "other urban," the migration rates were 24.2 and 26.4, respectively. No further subdivision by urban regions was made.

Undoubtedly the relationship between a migration rate preceding a survey and the proportions and dating of rural births that are misallocated to the urban division is complex. Nevertheless, the assumption of a reasonably direct linkage is justified since the source and size of error are clearly tied to the proportion of women in the childbearing ages who are migrants. On this basis, the Ankara standard of error was assumed to be applicable as an adjustment factor, when multiplied by the ratio of the divisional migration rates to the Ankara migration rate. These ratios are shown below:

Istanbul-Izmir: $r = 24.2/61.5 = .393$
Other urban : $r = 26.4/61.5 = .429$

The standard (Ankara) migration errors in the mortality estimates, dated according to the period of birth and stated as proportions of the "true" infant mortality rate, are as follows:

Period of Birth	Standard (Ankara) Error
1950-59	.186
1960-65	.050

Since information on the extent of pre-migration childbearing is not available prior to the 1950s, it was assumed that the proportionate error is the same for 1945-50 as immediately thereafter. In order to indicate gradual changes in the extent of pre-migration childbearing over all the years for which adjustments are needed (1945-67), the standard was interpolated and extended a short distance at each end, as follows:

1945 to 1955	.186 (as estimated)
linear decrease to:	
1963	.050 (as estimated)
linear decrease to:	
1967	.025 (by assumption)

An adjustment multiplier, m, for application to the preliminary urban mortality rates was then calculated as follows:

$$m = 1/[1+(r)(s)]$$

For example, the multiplier for Istanbul-Izmir in 1945 is $1/[1 + (.393)(.186)] = .932$. The preliminary infant mortality rate of 190 per thousand is then adjusted by this multiplier to 177 per thousand. The adjustments for the urban divisions were carried out for all dates in the same way, after considering a second type of birth misallocation.

Errors Due to Transfer of Communities from Rural to Urban Status

Part of the urban sector in 1968 was still rural at earlier dates. Therefore, women residing in 1968 in places that had transferred from rural to urban status reported some births that were pre-transfer births. The proportion of urban births that are misclassified as rural births due to this change in status increases as estimates are made for dates further back in time. The Ankara study does not identify error of this type because all the interviews were held in Ankara city, which had been an urban place at all the earlier dates.

The rural places in 1945 that transferred to the urban sector by 1968 were listed and found to have a population of approximately .50 million in 1945 as compared with an urban population of 3.44 million at that time. The relationship between these two population sizes immediately suggests that the allocation of rural births to the urban sector in 1945 by reports of women in 1968 is not small. Table 22 presents an approximation of the error in 1945 made on the basis of some simple and plausible assumptions. The column on the rural sector is included not out of necessity for the computations but to draw attention to the large size of the rural sector in terms of births and deaths relative to the size of the urban sector at that time.

The effects of community transfers are evaluated for the urban sector as a whole, because records for Istanbul and Izmir to trace the transfer of rural communities into the urban sector and from there to annexation by expansion of the municipal boundaries are not available. The Istanbul-Izmir division is defined by its municipal boundaries at the different dates of the study. The results of the computation at 1945 show that the migration-adjusted mortality rate for all urban areas must be adjusted additionally for community transfers by a multiplier as follows (Table 22):

$$(\text{line } 8) \ / \ (\text{line } 5) = 193 \ / \ 213 = .906.$$

Since this cause of error approaches zero as the date of the estimate approaches the survey date, a linear interpolation from .906 to 1.000 from 1945 to 1967, respectively, was used to provide a multiplier for each date. These multipliers are shown in column t, Table 23.

Final Estimates

The final adjustment of the urban trends of infant mortality, consisting of an adjustment for both migration of mothers and transfers of communities, is shown in

TABLE 22 Adjustment of Urban Infant Mortality Rate for Transfer of Rural Communities to Urban Sector, 1945: Turkey

Situation in 1945	Rural	Urban
Actual situation in 1945		
1. Population (millions)	15.35	3.44
2. Crude birth rate (per thousand)	49.4	26.6
3. Births (thousands)	758.3	91.5
As seen from 1968		
4. Births (thousands)	733.6	116.2
5. Migration-adjusted infant mortality rate (per thousand)	287	213
6. Deaths up to age 1 (thousands)	210.5	24.8
Actual mortality in 1945		
7. Deaths up to age 1 (thousands)	217.6	17.7
8. Infant mortality rate (per thousand)	287	193

Notes

Line 1:	From Table 9.
Line 2:	The birth rates are population-weighted means calculated for rural and urban from Table 11. The birth rates themselves are estimated utilizing infant mortality as a parameter. A trial value for urban infant mortality was computed in the format of the present table, followed by revision of the crude birth rate and a second trial. This process of successive approximation was repeated until mutually consistent adjusted mortality rates (Table 23) and crude birth rates (Table 11) were reached. The convergence was rapid because the crude birth rate is estimated with a second independent parameter, C(10), which has a strong effect on the final estimate of the crude birth rate.
Line 3:	(1) x (2).
Line 4:	Reflects transfer of rural births from rural to urban, .5 x 49.4 = 24.7.
Line 5:	The rural mortality rate does not require adjustment. The urban mortality rate comes from the original unadjusted mortality rates adjusted for migration as explained in the text. The migration-adjusted urban mortality rate used here is the birth-weighted mean of the urban divisional mortality rates.
Line 6:	(4) x (5).
Line 7:	Reflects transfer of misallocated rural deaths from urban to rural, 24.7 x .287 = 7.1.
Line 8:	(7)/(3).

Table 23. As explained above, the rural estimates do not require adjustment, so they are the same as those in the rural columns of Table 20.

The general pattern of differentials and trends across divisions, shown in Figure 18, may be accepted as valid, but there should be skepticism about specific values at particular dates. The picture is one of much higher rural than urban infant mortality at the earliest dates.

TABLE 23 Urban Infant Mortality Rates Adjusted for Reporting Error Due to Migration of Mothers and Transfers of Communities from Rural to Urban, 1945-67: Turkey

Exact Reference Date[a]	Adjustments s	t	Istanbul and Izmir	Other Urban West	Urban Central and East
1945	.186	.906	160	181	211
1947	.186	.915	154	176	204
1949	.186	.923	151	171	197
1951	.186	.932	142	167	191
1953	.186	.940	138	163	182
1955	.186	.949	132	158	177
1957	.152	.957	126	155	172
1959	.118	.966	120	150	166
1961	.084	.974	117	148	159
1963	.050	.983	110	141	153
1965	.038	.991	105	138	145
1967	.025	1.000	99	134	139
			r = .393	*r* = .429	*r* = .429

Note: The multiplier is: M = [1/(1 + *r*s)] x t, where s is the standard, *r* is the ratio for the division to the standard, and t is the adjustment for community transfers from rural to urban. See text for details and an example of the calculations.

[a] See note a, Table 18.

The rural mortality rates are spread across a large range with especially high mortality rates in the central part of Turkey. Estimates for the eastern rural area, which includes the southeast, are not the highest even though social indicators consistently rank this rural region lowest in Turkey during the period evaluated here. The rate of decline of mortality rates, however, is most rapid in the central region. By the 1960s, rural differentials essentially disappear across all three regions. This equalization, however, is not accomplished by reaching what would be considered "low" levels of infant mortality in all divisions, because even levels on the order of 160 per thousand (the combined rural estimate in 1967) certainly must be regarded as still high. Small differences among the rural regions and rearrangements of rank order at the end of the period are not significant, because the strength of the data cannot support precise measurement. The general rural pattern, and the convergence of rural trends by the mid-1960s, are acceptable findings.

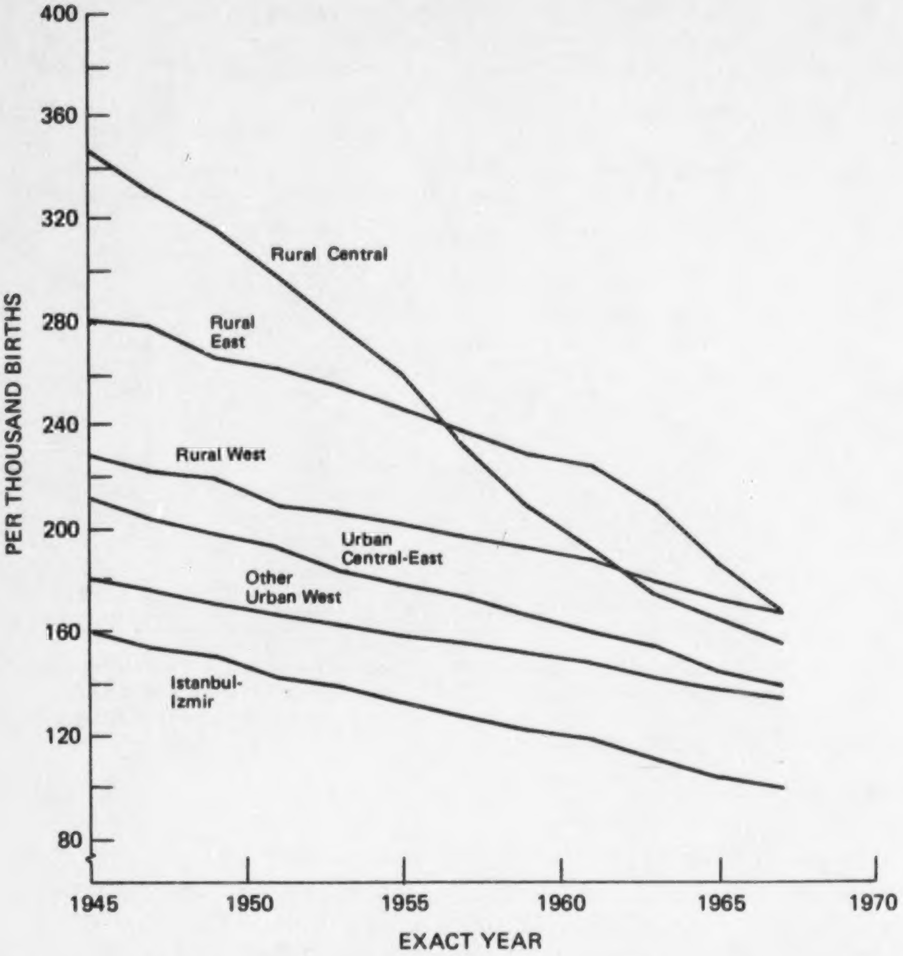


FIGURE 18 Infant Mortality Rates by Divisions, 1945-67: Turkey

Urban mortality rates declined more slowly than the rural ones and there was little change in the urban differentials across regions. Infants and young children continued to survive in 1967 more successfully if born and reared in a metropolitan city than in rural or less urban communities, just as was true two decades earlier.

Infant Mortality by Province

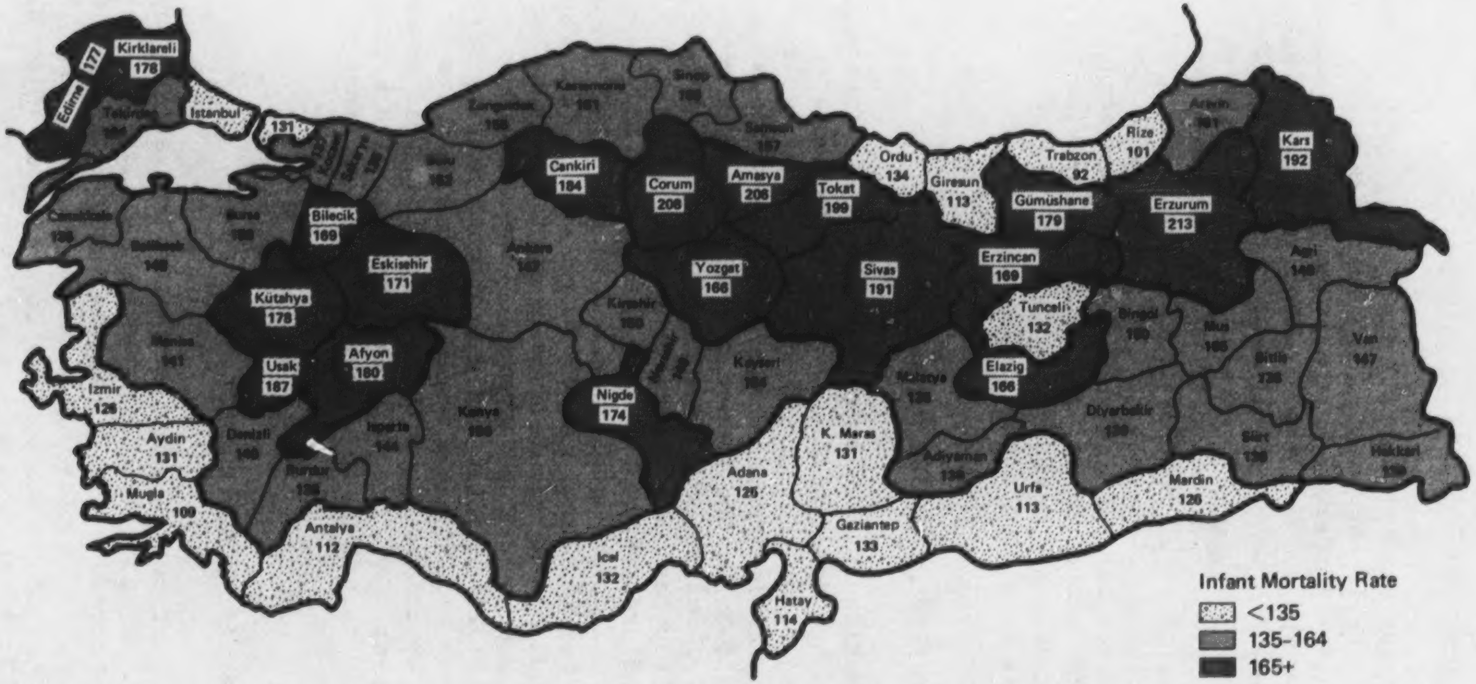
The 1970 census was tabulated and published by province. It included the "Brass questions," which are used to estimate infant mortality by the Brass-Trussell method. Since the census volumes also present the data separately for the rural and urban populations, a rather finely drawn picture can be produced of infant mortality at the provincial level. Variation in age misstatement and completeness of reporting for children born who died following birth are sources of error. A map of the results (Figure 19) and the more detailed presentation for rural and urban separately (Table 24) provide unusual and valuable material for use in conjunction with other social data at the provincial level.

Infant Mortality by Social Class

Some information is available regarding infant mortality differences by social class, but it is limited in coverage and time. The Ankara study (Adlakha, 1970) makes a distinction between upper and lower status women. In 1950-59, the two status groups accounted, respectively, for 35 percent and 65 percent of total births. The urban infant mortality rates were 93 and 149 per thousand, respectively. For the next period, 1960-65, the infant mortality rates by social status were 47 and 123 per thousand, respectively. (Some farmers were left out of the tabulations by social status, so these data are not fully comparable with the urban mortality estimates cited above from the Ankara survey.) When differences of infant mortality by social status are this large by comparison with the divisional differences, it is apparent that more information classified by social status would be useful to detect mortality differentials in Turkey.

NATIONAL MORTALITY ABOVE AGE 5, 1935-75

The method most suitable for estimating mortality above age 5 in Turkey is forward projection, utilizing a cumulation procedure that minimizes the effects of age misreporting. In a closed population an intercensal life table from childhood onwards may be estimated "directly" by tracing birth cohorts from one census to the next.


Edirne
177
Kirklareli
178
Tekirdag
Istanbul
131
Kocaeli
Sakarya
Zonguldak
Kastamonu
Sinop
Samsun
157
Bolu
Canakkale
Balikesir
Bursa
Bilecik
169
Eskisehir
171
Kütahya
178
Manisa
141
Usak
187
Afyon
180
Izmir
126
Aydin
131
Denizli
Isparta
144
Burdur
Mugla
100
Antalya
112
Konya
Ankara
147
Kirsehir
Nevsehir
Cankiri
184
Corum
208
Amasya
206
Tokat
199
Yozgat
166
Sivas
191
Nigde
174
Kayseri
Icel
132
Adana
126
Hatay
114
K. Maras
131
Gaziantep
133
Malatya
Adiyaman
Ordu
134
Giresun
113
Trabzon
92
Rize
101
Artvin
Kars
192
Gümüshane
179
Erzurum
213
Erzincan
169
Tunceli
132
Elazig
166
Bingol
Mus
Agri
Van
Bitlis
Diyarbakir
Siirt
Hakkari
Urfa
113
Mardin
126
Infant Mortality Rate
<135
135-164
165+

'IGURE 19 Infant Mortality Rates by Provinces, 1967 (per thousand population): Turkey

These estimates will be correct only if the population is truly closed, the two censuses have the same level of completeness, and there is no age misreporting. In actual populations these assumptions rarely hold simultaneously. Yet, by combining these ideas with their model life-table system, Coale and Demeny (United Nations, 1967) devised a technique that attempts to identify the mortality level to which a population is subject on the basis of intercensal comparisons. This technique assumes that the age pattern of mortality in the observed population conforms to a selected mortality pattern from a family of model life tables such as those of Coale and Demeny (1966).

Once a pattern has been selected, the population enumerated at the first census is projected to the time of the second census (forward projection) by using survival rates derived from a range of mortality levels from the chosen family of model life tables. For each age x, a model life table is selected that reproduces by forward projection exactly the observed population over age x+t at the second census (t being the length of the intercensal interval). A representative mortality level is then chosen, generally by taking the median of the life tables selected to match the populations projected above the ages 5, 10, ... 40, 45. Because the population is cumulated in each projection for ages x and over, rather than handled separately by five or ten-year cohorts to estimate mortality levels, the effects of age reporting errors are minimized though not necessarily eliminated. The estimates yielded by this technique are generally acceptable, but they are sensitive to differential completeness of enumeration between the censuses used.

The method is at its best when the intercensal interval is 5 rather than 10 years, and it can provide estimates when satisfactory death registration data are not available. Both of those conditions prevail in Turkey and have made the method particularly suitable (Demeny and Shorter, 1968). The data requirements are a series of censuses and information on international migration. The latter is used to adjust the initial (or terminal) census in each five-year pair of censuses so that the two censuses represent a population closed to migration. After this adjustment, the only remaining source of population change above age t is mortality, which is estimated by the forward projection technique.

TABLE 24 Infant Mortality and Fertility Indexes by Province, Circa 1967 and 1960: Turkey

	Infant Mortality, Around 1967 (per thousand births)			Fertility, Around 1960	
Province	Rural	Urban	Total	CBR (per thousand)	TFR (per woman)
(1)	(2)	(3)	(4)	(5)	(6)
1 Adana	128	123	125	46.7	7.10
2 Adiyaman	136	148	139	58.4	7.97
3 Afyon	189	149	180	49.2	6.91
4 Agri	149	146	148	59.9	9.19
5 Amasya	218	174	206	41.1	5.67
6 Ankara	177	134	147	40.5	5.52
7 Antalya	110	118	112	46.5	6.68
8 Artvin	165	136	161	44.8	6.15
9 Aydin	137	117	131	35.5	4.75
10 Balikesir	160	121	148	35.5	4.83
11 Bilecik	173	162	169	35.8	4.72
12 Bingol	146	170	150	63.5	9.40
13 Bitlis	134	140	136	65.0	10.10
14 Bolu	157	130	152	40.9	5.65
15 Burdur	144	123	138	41.0	5.83
16 Bursa	173	138	158	33.9	4.45
17 Canakkale	142	116	136	32.4	4.52
18 Cankiri	192	149	184	52.6	7.10
19 Corum	215	181	208	50.5	6.74
20 Denizli	148	118	140	42.1	5.68
21 Diyarbakir	136	144	139	56.4	8.59
22 Edirne	190	149	177	37.4	5.19
23 Elazig	164	167	166	55.5	7.86
24 Erzincan	173	157	169	53.8	7.74
25 Erzurum	214	210	213	51.4	7.32
26 Eskisehir	195	146	171	40.7	5.71
27 Gaziantep	133	132	133	48.0	6.86
28 Giresun	115	104	113	53.7	7.27
29 Gumushane	182	159	179	53.8	6.78
30 Hakkari	140	136	139	67.7	10.56
31 Hatay	120	105	114	50.7	7.68
32 Isparta	158	116	144	40.0	5.86
33 Icel	141	122	132	43.8	6.54
34 Istanbul	135	126	131	23.1	3.04
35 Izmir	130	121	126	29.8	3.99
36 Kars	197	170	192	58.0	8.84
37 Kastamonu	168	122	161	40.3	5.43
38 Kayseri	175	146	164	52.3	7.35
39 Kirklareli	196	140	178	35.1	5.13
40 Kirsehir	156	128	150	59.3	8.51
41 Kocaeli	143	131	137	35.1	4.96
42 Konya	167	142	159	51.3	7.37
43 Kutahya	183	159	178	37.2	4.84
44 Malatya	139	129	135	56.7	8.14
45 Manisa	145	132	141	36.1	4.93

TABLE 24 (continued)

	Infant Mortality, Around 1967 (per thousand births)			Fertility, Around 1960	
Province	Rural	Urban	Total	CBR (per thousand)	TFR (per woman)
(1)	(2)	(3)	(4)	(5)	(6)
46 Maras	131	131	131	55.1	8.01
47 Mardin	125	129	126	60.1	8.65
48 Mugla	112	92	109	40.1	5.71
49 Mus	158	143	155	64.5	9.61
50 Nevsehir	151	142	149	54.1	7.54
51 Nigde	179	157	174	54.7	7.76
52 Ordu	137	121	134	58.8	7.49
53 Rize	101	101	101	52.1	7.05
54 Sakarya	139	127	136	40.3	5.72
55 Samsun	160	147	157	46.7	6.51
56 Siirt	142	134	139	61.9	8.98
57 Sinop	165	124	159	45.3	6.34
58 Sivas	198	170	191	54.6	7.44
59 Tekirdag	175	142	164	35.1	5.05
60 Tokat	207	174	199	51.1	6.96
61 Trabzon	91	96	92	53.1	7.20
62 Tunceli	135	123	132	63.2	9.41
63 Urfa	109	118	113	56.8	8.15
64 Usak	198	164	187	42.4	5.66
65 Van	155	127	147	63.5	9.52
66 Yozgat	169	149	166	54.0	7.54
67 Zonguldak	167	124	155	41.8	5.90
Total	157	134	149	45.1	6.30

Effects of International Migration

Between 1935 and 1960, the balance of international migration was positive, due to the relocation in Turkey of small Turkish populations from the Balkan countries. After 1960, Turkish workers were attracted in great numbers to West European labor markets, primarily West Germany, and the balance of migration became negative. Statistics on these movements, presented in Appendix D, are adequate to describe general orders of magnitude but are not of high quality. Statistics on total migration by sex are more reliable than those that describe the distributions by age. Fortunately, the forward projection method is not affected seriously by errors in the age distributions, because this form of error is similar to age misstatement. The forward projection method uses a cumulation procedure that minimizes estimation error caused by age mistatement.

Age Pattern of Mortality Above Age 5

Model life tables that represent the age pattern of Turkish mortality above age 5 are needed in the forward projection method of mortality estimation. Once again, the life table of the Turkish Demographic Survey was used to choose among the Coale-Demeny regional families, which are indexed by level numbers. The choice is made by examining the levels within a family that exactly match the expectations of life at each age from age 5 upward. The relevant range for matching is from age 5 to 45, because the forward projection method cumulates the projections of deaths and survivors from ages within this range to the end of life. Some differences from actual age patterns of the selected model family above age 45 are tolerable so long as the cumulative measure, e_x, within the range x=5 to 45, matches well.

The goodness of fit of each family is shown by the chart in Figure 20. A precise horizontal line indicates a perfect fit of the family to the Turkish life table. The chart is constructed by calculating an index of fit, R_x:

$$R_x = (\text{Level at } e_x) \div (\text{Level at } e_5)$$

The Coale-Demeny families of models are indexed continuously from 1 to 24 within a family, the level number rising with increased expectation of life. At each value of e_x in the Turkish life table there is a unique model level in the family of models in question that has the same value of e_x. These unique matches are found for each value of e_x and divided in the expression above by the model level at e_5. Thus, the index of fit R_x takes a value of 1.0 at age 5 by definition. At higher ages R_x varies for each family and sex.

"East" fits marginally better than "West," particularly for females, but there is little overall difference in goodness of fit between the two. The other two families are clearly less good matches. The choice of the "East" family above age 5 is independent of the choice made earlier to use "East" for infant and early childhood mortality. The model levels, as well as the

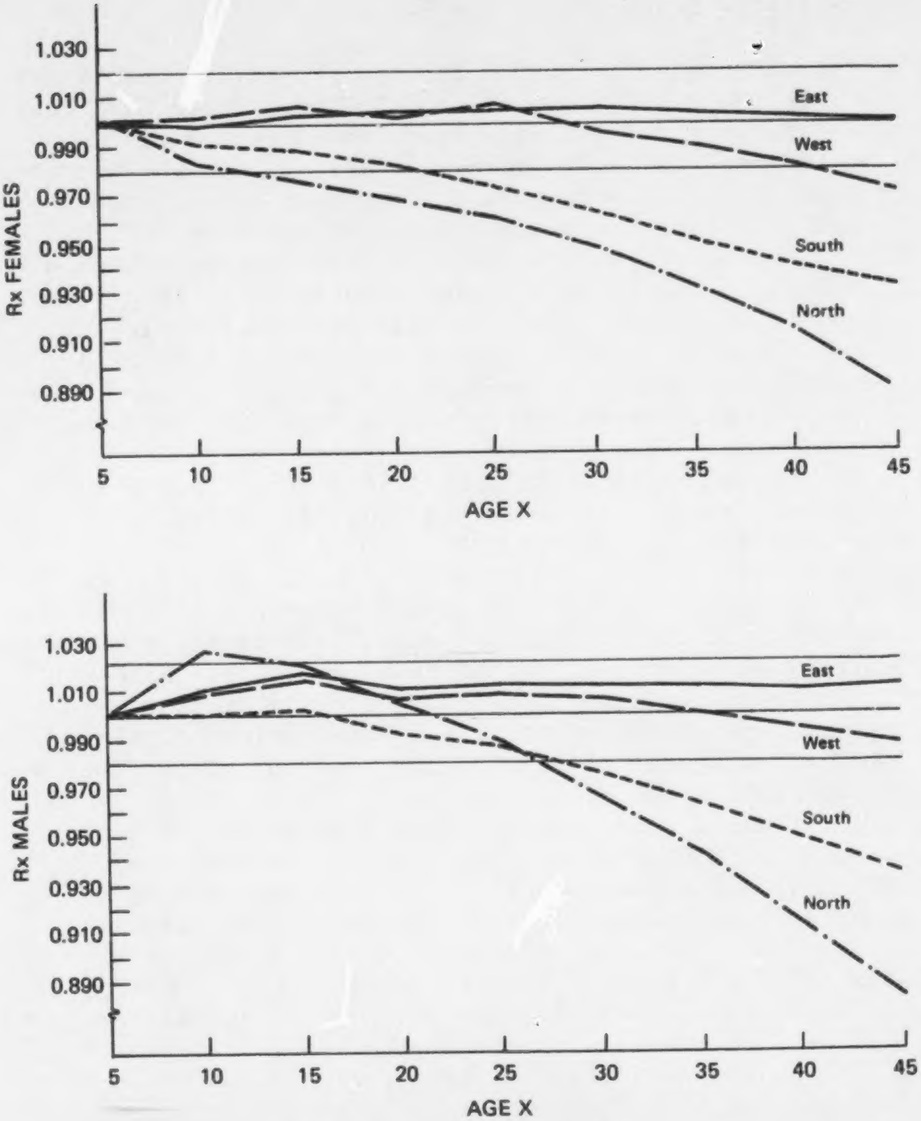


FIGURE 20 Comparison of Mortality Above Age 5 in Turkish Life Tables with Four Families of Model Life Tables: Turkey

families, were finally selected independently for adult and child mortality and then joined to form unique "split-level" models, as explained in the next section. Here, for adult mortality estimates, only the choice of a family above age 5 is needed.

Mortality Estimates Above Age 5

The results of applying the forward projection method are shown in Table 25, columns 2 and 3, and plotted in Figure 21. Estimates for a single intercensal period are sensitive to changes in census coverage, because increases in coverage cause survivorship to appear higher than it is and decreases in coverage have the opposite effect. Over a number of periods the total increase or decrease in census coverage can be assumed to be small even though estimates for particular five-year periods are elevated or depressed in irregular sequences. It is justified, therefore, to arrive at measures of a trend by smoothing with a graphing procedure, which is shown by the dashed line in Figure 21 and in columns 4 and 5 of Table 25.

Estimates through 1950 were allowed to stand without smoothing, because it is very likely that death rates were indeed higher in the 1940-1945 period than in earlier and later periods. From 1939 to 1946, Turkey faced several epidemics and severe shortages of food, especially in the cities, and a scarcity of drugs (Turkey, Ministry of Health and Social Welfare, 1973). Although estimates of mortality levels cannot be made from such information, the decrease in the expectation of life could be explained by such factors instead of by changes in census coverage.

For periods after 1950, a smooth trend can be graphed without difficulty except for the last five-year period, 1970-1975. The forward projection estimate for males appears to be unusually high relative to the previous period and relative to the gain in life expectancy measured for females. Several types of data error could be responsible, including migration error and an increase in census coverage as compared with 1970. For example, if the balance of male migration were assumed to be zero instead of -248,000 (Appendix Table D-1), the estimate of expectation of life at age 5 would drop from 69.7 years to 65.3 years.

At the time of the 1975 census (October), many Turkish males had not returned to their jobs in West Germany following the summer holidays. The economic recession in West Germany at that time caused restrictions and reduced incentives for workers to move there for jobs. The West German data on workers (see Appendix D) are not altogether adequate to date the worker flows. To the extent that Turkish workers are counted as outmigrants (part of the stock in Germany) and are enumerated at the same time in

TABLE 25 Estimates of Mortality Above Age 5 by Forward Projection, 1935-75: Turkey

Dating of the Estimate	Expectation of Life in Years at Age 5, "East" Models			
	Preliminary Estimates by Forward Projection		Final Estimates by Graphing	
	Males	Females	Males	Females
(1)	(2)	(3)	(4)	(5)
1935-40	51.4	50.2	51.4	50.2
1940-45	47.6	47.9	47.6	47.9
1945-50	56.9[a]	57.1[b]	53.1	54.0
1950-55	56.9[a]	57.1[b]	57.8	59.1
1955-60	63.4	64.8	60.4	61.9
1960-65	60.4	61.2	62.3	63.8
1965-70	61.5	64.3	63.5	65.5
1970-75	69.7[b]	67.1[b]	64.3	66.6

[a] A ten-year estimate was made in order to avoid using the 1950 census, which appears to have lower coverage of males and higher coverage of females than the previous or following censuses, causing disturbances in the orderly trend of estimates. The five-year points were then interpolated before making the final estimates by graphing.

[b] See discussion in text.

the de facto Turkish census, an upward bias is given to the estimated expectation of life at age 5 for 1970-75.

Another piece of evidence that weighs in the judgment about recent levels of mortality above age 5 is the life table being used, one based on TDS data for 1966-67 (Table 16). The life table shows an expectation of life at age 5 of 62.7 years for females and 60.2 years for males. The reference period is a year centered on 1967.2. For that same date the graphed estimates (after smoothing) in Figure 21 are 65.0 for females and 63.2 for males. The TDS evidence weighs against accepting higher estimates for life expectancy than the graphed trend. Since the life table provides estimates for one date only, rather than successive estimates over time by a comparable method, some difference between the level of the TDS estimates and the level of the trends graphed in Figure 21 is acceptable.

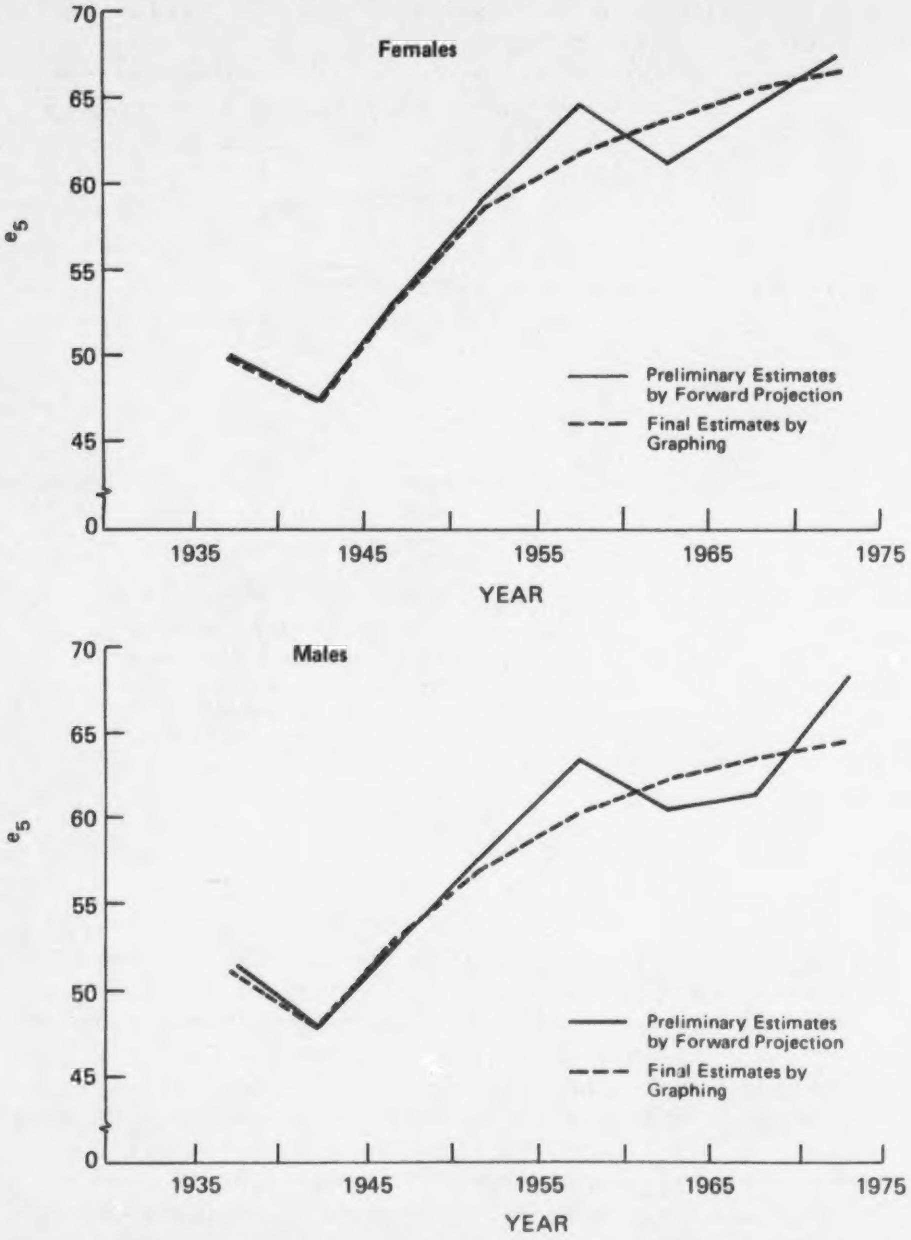


FIGURE 21 Estimates of Mortality Above Age 5 by Forward Projection, 1935-75: Turkey

NATIONAL GENERAL MORTALITY, 1935-75

While estimates of infant mortality and mortality rates above age 5 are valuable in themselves, the purpose of the following sections is to derive combined measures that express the general mortality of the population as a whole. This is done by constructing complete life tables for various dates that may be accepted as representative for the population as a whole.

Expectation of Life at Birth

The most general index of mortality is the expectation of life at birth, e_o, which summarizes the average survival experience of persons born into the population up to the end of life. Estimates of infant and early childhood mortality are joined with estimates of mortality above age 5 to form this general index. In effect, two life-table segments, one representing child mortality and one representing adult mortality, are joined to form a single life table that describes mortality in its entirety.

Numerically, the procedure is to utilize the following definition from the life table (radix = 1.):

$$e_o = {}_5L_o + T_5 = {}_5L_o + l_5 \times e_5$$

where ${}_5L_o$ and l_5 are from the life table representing mortality below age 5 and e_5 corresponds with a life table above age 5. As an example, the calculations for 1970-75 are shown below.

The index for child mortality is an infant mortality rate (${}_1q_o$) for both sexes combined of .126. This rate corresponds with a particular "East" model life table from which the corresponding indexes for ${}_5L_o$ and l_5 are derived for each sex separately (radix = 1.). The "East" model relationship of the sexes is assumed.

Index	Females	Males
${}_5L_o$	4.357	4.244
l_5	.8456	.8219

The measures of e_5 by sex for 1970-75 are from Table 25: 66.6 years for females and 64.3 years for males.

(1) e_o (females) = 4.357 + (.8456)(66.6) = 60.7
(2) e_o (males) = 4.244 + (.8219)(64.3) = 57.1
(3) e_o (both sexes) = [60.7 + (1.05)(57.1)] ÷ 2.05 = 58.9

The final equation for both sexes (3) recombines child mortality and exactly eliminates the "East" model assumption about sex differentials. The estimate resting most firmly on Turkish data, therefore, is the expectation of life at birth for both sexes combined.

Inspection of the actual sex differential in child mortality at the national level shows a difference from "East." In Table 26 the proportions of each sex dying up to ages 1 and 5 are taken from the 1966-67 life table. As in most populations, male mortality rates are higher in Turkey than female rates. However, they are not quite as much higher as the "East" model relationship predicts. Compared with the "East" populations (historical life tables of central and eastern Europe; north and central Italy), Turkish female infants and young children have lower survival rates. Consequently, there is a slight upward bias in estimates of e_o for females, and a corresponding downward bias for males. The bias calculated for 1966-67 is +0.2 years for females; for males it is -0.2 multiplied by the reciprocal of the sex ratio at birth. The bias at other dates is not known. For both sexes combined, however, no such bias exists (Table 27).

TABLE 26 Sex Differentials in Infant and Early Childhood Mortality Compared with Differentials Predicted by the "East" Models: Turkey

	Proportions Dying Up to Age x ($_xq_o$)		
	TDS Life Table		
Age x	Females	Males	Males Predicted by "East" from Females
1	.144	.162	.172
5	.192	.213	.219

TABLE 27 Expectation of Life at Birth, 1945-75: Turkey

Period	Females	Males	Both Sexes
1945-50	39.6	36.7	38.1
1950-55	45.2	42.0	43.6
1955-60	49.7	46.5	48.1
1960-65	53.7	50.5	52.1
1965-70	57.4	53.9	55.6
1970-75	60.7	57.1	58.9

Deviant Child-Adult Age Pattern

Although the age pattern of Turkish mortality is well represented by the model life tables within the age ranges below and above age 5, the overall Turkish relationship of child to adult mortality deviates markedly from the "East" pattern. This can be seen by noting the infant mortality rate that is predicted by the model life table from the known expectation of life at age 5, or by making the prediction starting from infant mortality as the known value. These two ways of viewing the deviant character of Turkish mortality are shown in Figure 22.

None of the four families of model life tables closes the gap displayed in the figure. The "South" models are somewhat closer to the Turkish child-adult relationship, but still far removed (Demeny and Shorter, 1968). It must be concluded, therefore, that high Turkish death rates in infancy and early childhood, as compared with mortality at higher ages, exceed the "normal" bounds observed in the history of Europe and other now-developed countries that are the basis for the Coale-Demeny models. This in no way damages the estimates made above of child, adult, and general mortality, because the models are used independently above and below age 5.

The deviation from "normal," taking "East" as a standard of normal, increases from the date of the first available measurement (1945-50) until around 1960. It peaks in 1960-65 by one index and in 1955-60 by the other. Thereafter the gap diminishes. Thus, it is evident that the decline of child mortality lags behind

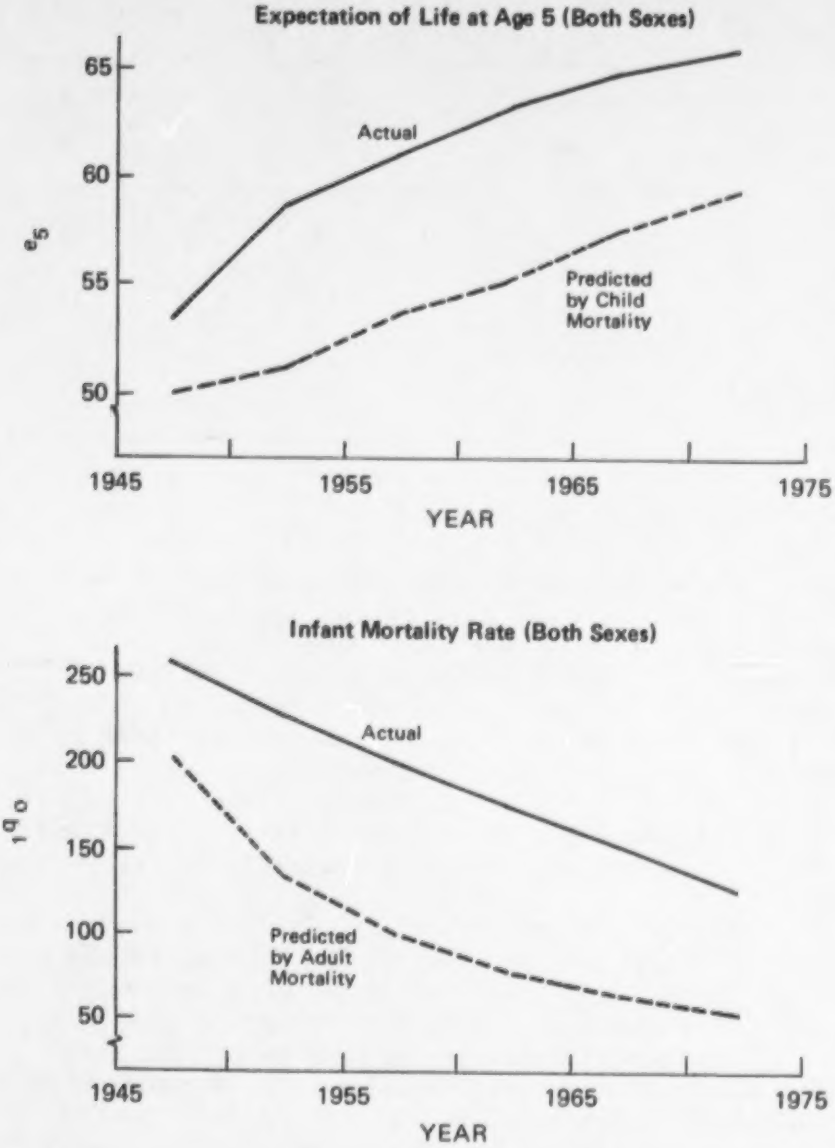


FIGURE 22 Changes in the Deviant Child-Adult Pattern of Turkish Mortality, 1945-75: Turkey

that of adult. The size of the gap may be interpreted as a measure of the inequality in health status between children and older persons, relative to an "East" historical standard.

Assumptions for Multiple Reverse Projections

The mortality assumptions needed for multiple reverse projections are now in hand for 1935 to 1975, excepting only infant and early childhood mortality for the earliest ten years, 1935 to 1945. The relationship of adult to child mortality just noted provides a basis for carrying the infant mortality assumptions back to this early period. The measured gap, in terms of the index $_1q_0$ in Figure 22 expands from .054 in 1945-50 to .103 in 1955-60, doubling in ten years. A simple reverse extrapolation to about one-half the initial value for ten years earlier in 1935-40 justifies an assumed gap at that time of .025. During the war years, 1940-45, very high adult mortality presumably caused the child-adult gap to disappear temporarily, so no gap is assumed. Based on these plausible assumptions the levels of infant mortality implied by adult mortality in 1935-40 and 1940-45 respectively were 273 and 306 per thousand assuming the relations of the "East" family of life tables. These assumed values for infant mortality complete the estimates needed as assumptions for the multiple reverse projections and are shown in Table 28.

TABLE 28 National Mortality Assumptions of the Multiple Reverse Projections, 1935-75: Turkey

Reverse Projection Period	Infant Mortality Rate, Both Sexes (per 1000 births)	Expectation of Life at Age 5 (years)		Both Sexes e_0
		Males	Females	
1970-75	126	64.3	66.6	58.9
1965-70	151	63.5	65.5	55.6
1960-65	176	62.3	63.8	52.1
1955-60	203	60.4	61.9	48.1
1950-55	233	57.8	59.1	43.6
1945-50	260	53.1	54.0	38.1
1940-45	306	47.6	47.9	31.4
1935-40	273	51.4	50.2	35.4

Source: Tables 18 and 25; see related text.

4

National Population Growth, 1935-75

Estimates from the preceding chapters are now brought together to describe the general process of population increase at a national level.

COMPONENTS OF POPULATION INCREASE

Changes in population size (p) are determined by the net effect of three components of change: births (b), migration (m), and deaths (d). Each of these components can be expressed as an annual rate of change in population size. The rates are additive when defined as geometric rates of increase: $p = b + m - d$. This equation provides a convenient basis for discussing the components of population increase.

Births and Migration

The rate of increase in population due to births, b, is the same as the crude birth rate. The rate of population change due to migration, m, is calculated from estimates of international migration (Appendix Table D-2) divided by the geometric midperiod means of population size according to the censuses (Table 1). These results are shown in the first two columns of Table 29.

Deaths

The third component, deaths, is measured by two alternative approaches. The first approach is to calculate the intercensal rate of population increase

TABLE 29 Rates of Population Change and Two Alternative Estimates of the Death Rate, 1935-75: Turkey

	Rates of Population Change				Based on p from Reverse Projections	
Period of Estimate	Births b	Migrations m	Increase p	Deaths d Est. I	p^a	d Est. II
	(1)	(2)	(3)	(4)	(5)	(6)
1935-40	45.8	1.5	17.3	30.0	15.9	31.4
1940-45	43.3	.3	10.6	33.0	9.7	33.9
1945-50	46.0	.3	21.7	24.6	19.3	27.0
1950-55	48.3	1.3	27.8	21.8	26.1	23.5
1955-60	47.0	1.0	28.5	19.5	28.2	19.8
1960-65	43.2	-1.3	24.6	17.3	25.5	16.4
1965-70	38.8	-2.1	25.2	11.5	23.2	13.5
1970-75	34.9	-2.0	24.3	8.6	21.3	11.6

[a] The reverse projections are made from reported age distributions, except 1970-75, which is from an adjusted age distribution of a 1 percent sample of the 1975 census.

(from the population totals of Table 1), which gives p, shown in column 3 of Table 29, and then to utilize the equation, $d = b + m - p$. This first procedure yields Estimate I, shown in column 4 of Table 29.

The second approach is to utilize the rates of population increase implied by the multiple reverse projections (column 5 of Table 29) in the estimating equation. The result is Estimate II (shown in column 6). The two series of estimates are compared in Figure 23.

Each series of estimates has strengths and weaknesses. Estimate I errs in a downward direction whenever there is a relative increase in census coverage from one census to the next, because that raises p (column 3) erroneously. The upward kink in the curve of Estimate I at 1960-65 could be due to a decrease in census coverage in 1965 or to an increase in census coverage in 1970 (and 1975) relative to 1960. The reverse-projection estimates do not have this particular problem because, as explained in Chapter 2, each projection is made from a single census and therefore produces estimates that are independent of changes in census coverage.

In the reverse projections, the selected model life tables and age structures determine the number of persons

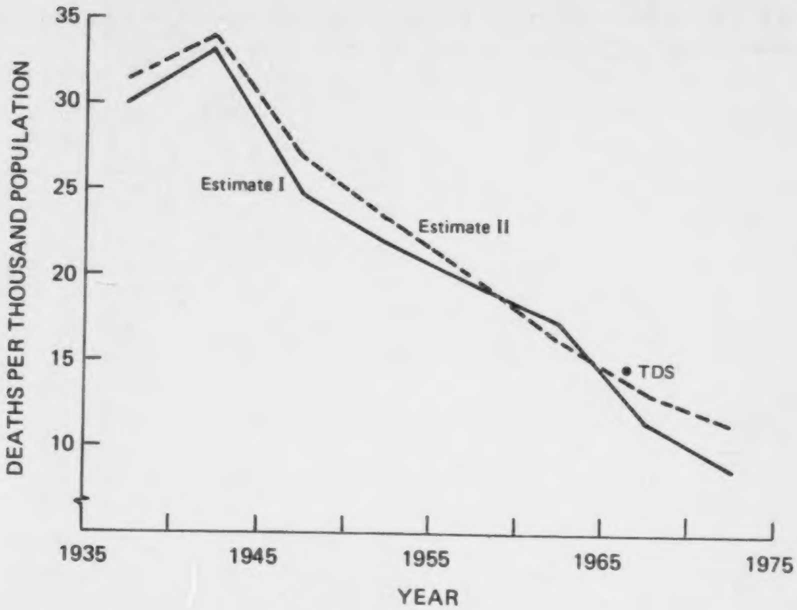


FIGURE 23 Alternative Estimates of the Crude Death Rate, 1935-75: Turkey

Source: Table 29.

removed from the population by death and hence are a factor in determining the rate of population increase, p (column 5). The age pattern of mortality involves most deaths at the very youngest and oldest ages, which are the locations in the age distribution most subject to errors of estimation. In addition, some error in the representation of Turkish conditions by the pattern of death rates in model life tables is to be expected at the extremities of age. This is not such a serious problem at young ages because reasonably strong estimates of infant and early childhood mortality are available (see Chapter 3), but adult mortality is not measured as accurately.

The level of Estimate II relative to Estimate I suggests that the errors in either or both series are systematic over time, because there is a more or less constant differential between the two. Whatever the source of the differences between Estimate I and II, the slope of the trend is very similar in both series. Thus, either estimate of trend would tell practically the same story. It is also reassuring to note that a wholly independent estimate of the death rate in 1966-67 by the Turkish Demographic Survey tends to confirm the level of Estimate II.

SUM OF COMPONENTS

Figure 5 in the Summary presents a convenient overall picture of the different components of population change and their sum, p, which is the rate of population increase. The two estimates of the death rate are averaged at each date for presentation in the upper panel. However, in order to show the official census estimates of the rate of population increase, an additional dashed curve of p is included in the lower panel. The general agreement of the two curves strengthens confidence in the estimated crude birth and death rates. Some error no doubt remains, particularly because estimates of international migration, which play a role in the indirect estimation procedures, are less strong than the other data.

Appendix A

Estimation of Fertility by Multiple Reverse Projection

Frederic C. Shorter

Reverse projection is known chiefly for its use in estimating past trends of fertility. Age structure is the crucial element of the census data from which inferences are drawn. Errors in the reporting of age are common in many countries, so use of census data for reverse projection requires methods that insulate the results from these age errors. Multiple reverse projection is such a method. It relies on reverse projections from a series of censuses arranged so that the effects of age reporting errors on estimates are systematically offset.

The method, and its application to the estimation of crude birth rates in Turkey, is explained in general terms in Chapter 2. The purpose of this appendix is to explain the data requirements of the method, its mathematical statement, and the results. One of the multiple reverse projections for Turkey is reproduced in detail below. This example illustrates how all components of population change--including fertility, mortality, and migration--are evaluated in a consistent manner over time.

DATA REQUIREMENTS

The minimum set of information needed for a reverse projection includes (1) a distribution of the population by age and sex and (2) assumptions about mortality over the period of the reverse projection. In a reverse projection, the number of births is reconstructed from information on the number of survivors in the current population distribution and the mortality to which they were subject in the past. Therefore, no fertility assumptions are necessary. Nevertheless, the results include numbers of births, crude birth rates, and general fertility rates.

The reverse projection is made by five-year age groups in steps of five years, going back in time as far as necessary. The minimum data may take the form of the following:

1. An age distribution for each sex in five-year age groups from age 0 to an open-ended interval 75+.
2. A set of life table survival rates for each sex for each five-year reverse projection period. These are normally selected from model life tables.

Optional data are the following:

3. For each sex separately, the proportion of the population aged 70+ that is aged 75+, based on data from actual censuses dated in multiples of five years prior to the starting date of the reverse projection. This information allows the distribution of population by age in the open interval, 75+, to be calculated using assumptions from the actual population rather than from the stationary population of the life table.
4. Net migration by five-year age groups for each sex for each five-year reverse-projection period. This information allows the effect of migration on the indirect estimates to be removed.
5. Age-specific and total fertility rates may also be calculated, if a standard age-specific fertility schedule is provided.

MATHEMATICAL STATEMENT

The basic element of a population projection is a group of persons whose common identification is their sex and period of birth. They form a birth cohort, which for convenience in calculations is defined as a five-year cohort. A reverse projection is made by "reverse surviving" each cohort separately back through time, in cycles of five years. Each cycle is a separate reverse projection providing the starting point for the next five years. The projection keeps track of each cohort separately as it is increased by reverse survival (deaths are restored to the population), by reversing in- and out-migrations, and removing cohorts from the population as the cohorts are carried back to birth. Cohorts are designated as follows for each five-year cycle:

Cohort index (c)	Age at Year -5	Age at year 0
0	Born	0-4
1	0-4	5-9
2	5-9	10-14
3	10-14	15-19
4	15-19	20-24
5	20-24	25-29
6	25-29	30-34
7	30-34	35-39
8	35-39	40-44
9	40-44	45-49
10	45-49	50-54
11	50-54	55-59
12	55-59	60-64
13	60-64	65-69
14	65-69	70-74
15	70-74	75-79
16	75+	80+

The reverse-survival equation, omitting migration for the moment, is as follows:

$$C^{-5}_{s,c} = C^{0}_{s,c}/S_{s,c} \quad (c = 0,16;\ \text{migration} = 0) \qquad (1)$$

where C is the five-year birth cohort, s stands for sex (male or female), c stands for the cohort index number, and S is the five-year survival rate. The superscript, 0 or -5, refers to the date in years.

When the reverse-survival equation is applied to the youngest birth cohort, c=0, the result is a quantity of births, B, during the five-year period:

$$B_{s} = C^{-5}_{s,o} \qquad (2)$$

At the upper end of the age distribution the two age groups 75-79 and 80+ are combined into 75+ in the initial data for year 0. In order to reverse-project this uppermost age group, the two cohorts that it contains (15 and 16) must be split out separately. The reverse-survival equation cannot be applied to cohorts 15 and 16 until this splitting has been performed.

In the absence of other information, the proportion of the life table population aged 75+ that is aged 75-79 is used as the basis for splitting:

$$C_{s,15} = [{}_5L_{75}/({}_5L_{75} + T_{80})] \cdot A \qquad (3)$$

$$C^{o}_{s,16} = A - C^{o}_{s,15} \qquad (4)$$

where ${}_5L_{75}$ and T_{80} are life table notation that refer respectively to person-years lived in the age interval 75-80 and from 80 years of age to the end of life. The notation A refers to the size of the given population that is aged 75+ at the base year of the projection (year 0).

The assumption of a stationary life table age distribution at the uppermost ages is usually incorrect in applied work, because mortality and fertility were neither equal nor constant in the past. Migration causes additional deviations from the stationary pattern. Nevertheless, for short reverse projections, such as five or ten years, an incorrect assumption about age structure at the highest ages will have a negligible effect on estimates of recent demographic rates (e.g., CBR and CDR). For longer reverse projections, however, the cumulative effect of error over a number of five-year cycles is a matter of concern.

A second approach to splitting the uppermost age group is to utilize independent information from a census at date -5 years concerning the actual distribution of population above age 70. Let p be the proportion of the population aged 70+ that is aged 75+ at date -5. The following four equations are solved for four unknowns to split out the two cohorts:

$$C^{-5}_{s,16} = p\,[C^{-5}_{s,15} + C^{-5}_{s,16}] \qquad \text{p is given} \qquad (5)$$

$$A = C^{o}_{s,15} + C^{o}_{s,16} \qquad \text{A is given} \qquad (6)$$

$$C^{-5}_{s,16} = C^{o}_{s,16}/S_{s,16} \qquad S_{s,16}\text{ is given} \qquad (7)$$

$$C^{-5}_{s,15} = C^{o}_{s,15}/S_{s,15} \qquad S_{s,15}\text{ is given} \qquad (8)$$

Four unknowns: $C^{-5}_{s,15}$; $C^{-5}_{s,16}$; $C^{o}_{s,15}$; $C^{o}_{s,16}$

An additional complexity is migration, which is included in the general formulation of the reverse projection. When migrations are distributed equally over the five-year period, a good approximation for the survival rate applicable to migrants is the following:

$$\frac{1+S_{s,c}}{2} \qquad \text{(for } c = 1,16\text{)}$$

For migrants in the youngest cohort, those who were born and who migrated during the interval, an approximation for the survival rate is the following (Shorter and Pasta, 1974:120-121):

$$.67 + .33\, S_{s,c}$$

To take migration into account equation (1) is replaced by two equations: one for the youngest cohorts (those born during the period) and a second for the remaining cohorts:

Youngest cohort:

$$C^{-5}_{s,o} = \frac{C^{o}_{s,o} - M_{s,o}[.67 + .33S_{s,o}]}{S_{s,o}} \qquad (9)$$

Remaining cohorts:

$$C^{-5}_{s,c} = \frac{C^{o}_{s,c} - M_{s,c}\ (1+S_{s,c})/2}{S_{s,c}} \qquad [c = 1,16] \qquad (10)$$

where $M_{s,c}$ refers to the migration information by sex and cohort. If the age group 75+ is split according to the procedures of equations (5) through (8), the effect of migration is included by substituting equation (10) for equations (7) and (8).

Births are produced separately by sex in the reverse projection. The sex ratio of births is a consequence of the relative sizes of the 0-4 age groups and the assumed mortality rates by sex. The proportion of births that are girls, g, where f and m refer to females and males respectively, is

$$g = C^{-5}_{f,c}/(C_{f,o} = C^{-5}_{m,o}) \qquad (11)$$

Various fertility indices are calculated from the resulting projection. Total births are the sum of births by sex given by equation (2). The crude birth rate is total births divided by the geometric mean of the total population at dates 0 and -5. The general fertility rate is total births divided by the geometric mean of female population aged 15 to 44 at dates 0 and -5.

Age-specific fertility rates are calculated by introducing independent information about the distribution of childbearing by age of woman. These data are a model age-specific fertility schedule or a representative schedule from the population itself, expressed as rates or as a percentage distribution across the age range of 15-49. The schedule is denoted by F^*_i where the index, i, refers to the 7 five-year age groups from 15 to 49. The shape of the schedule, not its level, is used to distribute births by age of woman and thus to estimate the age-specific fertility rates.

A preliminary step is to calculate the geometric mean of women in each age group from 15 to 49, $\overline{W}_i$. A trial number of births, B*, is then calculated as follows:

$$B^* = 5 \cdot \sum_{i=1}^{7} (F^*_i \cdot \overline{W}_i) \qquad (12)$$

Since the age-specific fertility rates, F^*_i, are not the actual ones, they must be revised by a multiplier, k, which brings B* into agreement with B.

$$k = B/B^* \qquad (13)$$

$$F_i = kF^*_i \quad [i = 1,7] \qquad (14)$$

The total fertility rate, T, is the sum of the age-specific rates:

$$T = 5 \cdot \sum_{i=1}^{7} F_i$$

MULTIPLE REVERSE PROJECTIONS FOR TURKEY

For the period from 1935 to 1975, there are nine censuses of which the last eight (1940 to 1975) provide the initial age data by sex for each reverse projection. The survival rates for 8 five-year periods (1935 to 1975) were taken from split-level "East" model life tables (Table 28). All the options for finer calculation and for the production of total fertility rates were used. The proportion of the population aged 70+ that was aged 75+ in each prior census (1935 to 1970) was obtained from the census age distributions (Table 1). Migration estimates provide assumptions for each five-year period from 1935 to 1975 (Appendix Table D-2). Standard schedules of age-specific fertility are also used (see section on standard fertility schedules).

The actual computations were made with a computer package available from the Population Council (Shorter and Pasta, 1974; Shorter, 1980). An example of the results for one reverse projection is shown in Table A-1.

The present study utilized multiple reverse projections based first upon age distributions as reported (Table 1) and then as adjusted for age misreporting (Appendix Table C-3). Standard fertility schedules were used reflecting both the "early 1960s" and the changing pattern assumptions.

The method works best when censuses are available at five-year intervals, but it can also be used with censuses spaced ten years apart. Using only the ten-year censuses for Turkey from 1945 to 1975, another series of estimates was produced. Both series are shown in Figure A-1. Since the reverse projections were made in steps of five years, estimates of the birth rate were obtained every five years and should be averaged over ten-year periods to reflect the lower degree of precision in the basic data.

```
 20       512.5      794.8     1059.2     1289.6     1236.5     1217.7     1503.5     1833.1
 25       751.0      488.9      770.1     1042.2     1273.7     1174.5     1166.6     1452.3
 30       601.5      713.5      472.8      757.1     1029.0     1211.1     1097.1     1092.6
 35       577.2      566.4      685.3      463.6      745.6      990.7     1143.6     1034.3
 40       500.8      535.6      538.6      665.0      454.1      720.6      942.1     1095.2
 45       358.4      456.3      502.0      517.1      642.9      436.8      685.5      903.6
 50       288.9      318.9      419.0      472.8      492.0      611.9      414.4      654.5
 55       252.1      248.2      283.9      383.5      437.7      457.3      571.8      388.8
 60       216.2      204.9      210.7      249.1      341.2      391.7      412.1      517.5
 65       196.5      160.7      161.4      173.0      208.5      288.2      333.8      353.4
 70       143.3      126.8      112.3      119.0      131.0      160.2      224.2      261.9
 75+      151.9      123.6      118.1      116.4      124.8      139.3      167.9      226.2
 TOT     9324.6     9826.3    10820.3    12294.3    14274.2    16432.3    18502.7    20417.2

 GRAND
 TOTAL  18778.7    19623.7    21494.2    24287.1    28052.4    32221.5    36363.2    40197.7

                     MIDPERIOD INDICES FOR FIVE-YEAR TIME PERIODS
POPULATION SIZE        19196.5    20537.6    22848.0    26101.9    30064.8    34229.8    38232.4
YEARLY BIRTHS            827.4      924.3     1057.2     1250.6     1382.2     1368.8     1263.0
YEARLY DEATHS            663.1      557.1      526.7      524.4      511.0      471.3      421.1
NET YEARLY MIGRANTS        4.7        6.9       28.1       26.9      -37.4      -69.2      -75.0

                       YEARLY RATES PER THOUSAND POPULATION
GFR=BIRTHS/FEM(15-44)    221.3      223.0      222.9      235.3      229.8      197.1      158.5

BIRTH RATE                43.1       45.0       46.3       47.9       46.0       40.0       33.0
DEATH RATE                34.5       27.1       23.1       20.1       17.0       13.8       11.0
NATURAL INCREASE           8.6       17.9       23.2       27.8       29.0       26.2       22.0
NET MIGRATION              0.2        0.3        1.2        1.0       -1.2       -2.0       -2.0
POP INCREASE               8.8       18.2       24.4       28.9       27.7       24.2       20.1
```

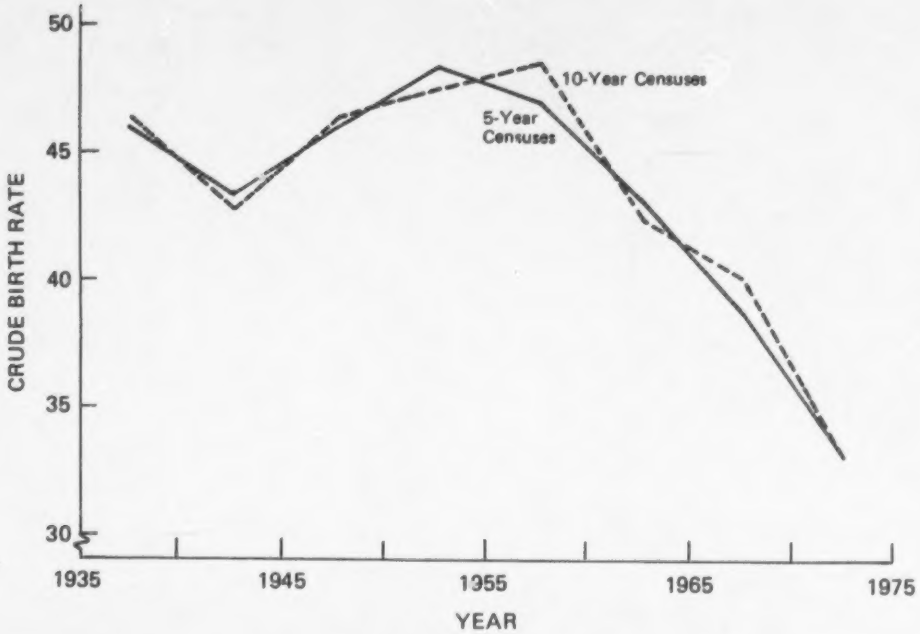


FIGURE A-1 Comparison of Estimates of CBR from Censuses Spaced Five and Ten Years Apart: Turkey (National, Reported Age Distributions)

Appendix B

Estimation of Trends in Infant and Early Childhood Mortality from Birth-Survival Histories

Miroslav Macura

This appendix describes a method for estimating time trends of infant and early childhood mortality for both sexes from birth-survival histories collected in a single sample survey. The method was developed expressly to estimate trends in Turkey from the birth-survival histories recorded in the 1968 Hacettepe survey. It was first employed in 1975 to obtain estimates for Turkey and her regional and urban-rural subpopulations (Macura, 1975a and 1975b). In the present study, the method was used to produce trend estimates for the six divisions of the country (Table 20).

DATA REQUIREMENTS

Application of the method entails the use of data routinely collected in birth-survival histories. The data refer to each live-born child and include: year of birth, the child's survival status at the time of survey, and the year of death if the child died before the survey year. The information is used to tabulate separately live-born and deceased children of both sexes by calendar year of birth. Among the former, only children born before the survey year are included. Among the latter, only those born and deceased before the year are covered. The tabulations are used to divide the numbers of deceased children by the corresponding numbers of live-born children by year of birth. The results are reported proportions dead prior to the survey year in single-year birth cohorts of children. The cohort proportions dead are used to estimate the trend of infant and early childhood mortality by the present method.

When estimates are sought for divisions of the country, as in the present study, women are classified by residence at the time of survey. The proportions dead obtained then pertain to selected divisions, subject to a number of reservations about the allocation of women's births to divisions different from present residence. Those are discussed in detail in Chapter 3.

APPLICATION OF THE METHOD

The method is described in two sections. The first explains a version of the method applicable to error-free data. In the second section, the version is extended to cope with certain imprecisions in data that normally arise in applying the method.

Estimation from Accurate Data

Let the year immediately prior to the survey year be denoted as t=0 and let time be measured in terms of calendar years, taking t=0 as the origin. Let d_a stand for the proportion dead at the end of the year t=0 in a cohort aged a years last birthday at this date. Let L_x be the life table number of person-years lived between exact years of age x and x+1. Now, there is an equation showing the relationship that exists between a cohort proportion dead and the cohort's probabilities of surviving through consecutive calendar years between birth and the end of t=0. If the life table radix, ℓ_0, is set equal to 1 and if an equation is written for each cohort, starting with the cohort aged 0 last birthday at the end of the year t=0, the following system of equations is obtained:

$$1 - (L_0)_0 = d_0$$

$$1 - (L_0)_{-1} \cdot (L_1/L_0)_0 = d_1$$

$$1 - (L_0)_{-2} \cdot (L_1/L_0)_{-1} \cdot (L_2/L_1)_0 = d_2$$

where subscripts of the survival ratios denote calendar years.

When information on d_a (for a=0, 1, 2, ...) is available from the birth-survival histories, the above equations make it possible to estimate the infant mortality rate, q(1), for each t (t=0, -1, -2,...) by utilizing Coale-Demeny model life tables (Coale and Demeny, 1966). The estimation procedure reduces to finding a model life table for each t, as follows.

First, a table for t=0 is located. It is the one that embodies the L_0 that satisfies the first equation. The table is found by interpolating linearly between both-sexes model life tables at integer levels of mortality of the selected Coale-Demeny family. It is then used to compute the survival ratios to which cohorts born before t=0 are exposed to in t=0: $(L_1/L_0)_0$, $(L_2/L_1)_0$,...

Next, a table for t=-1 is located. Given $(L_1/L_0)_0$, it embodies the L_0 for t=-1 that satisfies the second equation. The table is used to compute survival ratios to which cohorts born prior to t=-1 are exposed to in t=-1: $(L_1/L_0)_{-1}$, $(L_2/L_1)_{-1}$,...

Then, given $(L_1/L_0)_{-1}$ and $(L_2/L_1)_0$, the table for t=-2 which embodies the L_0 that satisfies the third equation is located. Further computations proceed in the same fashion.

Once the model tables for individual calendar years are located, the trend estimate is reached simply by associating the q(1)'s embodied in the tables with respective calendar years.

Estimation from Defective Data

Unless mortality rises strongly over time, the cohort proportions dead should increase as the cohort year of birth moves backward from t=0. When there are short-run fluctuations in mortality, the time schedule of proportions zigzags accordingly. Whenever the information used is defective, however, the schedules zigzag much more than could be possibly explained by the short-run fluctuations. Under most circumstances these excessive variations could plausibly be attributed to a more or less random misreporting of the year of birth and probably to sampling variance too. Both the misreporting and the sampling variance appear to affect the proportions of the cohorts born at earlier dates (say 20 to 30 years prior to t=0) more than those of cohorts born closer to the survey.

If the method is applied to proportions that are defective due to sampling variance and random misreporting, estimates of infant mortality rates referring to most of the years are biased; some are biased upward, the others downward. As a rule, estimates referring to years in which cohorts with unduly high proportions dead were born are upwardly biased and vice versa. Fortunately, it is largely possible to remove the bias arising from the data errors by utilizing smoothing, which is described next.

The proportions dead are first plotted against time (year of birth) and then approximated by a smooth, free-hand-drawn time schedule of proportions dead. Then, values of the proportions are read from the smooth schedule and converted into a trend estimate, as if the data utilized were error-free. Next, the time period spanned by the schedule is split into two intervals of approximately equal length and a ratio is calculated for each interval. The denominator of the ratio for the given time interval is the reported number of deaths that occurred before the survey year in cohorts born within the interval. The numerator is the number of deaths that would have occurred before the survey year if the cohorts born within the interval had been exposed to mortality conditions consistent with the smooth proportions.

To show how a ratio for a particular interval is computed, let S_a and D_a be, respectively, reported numbers of surviving and dying children before the end of $t=0$ in a cohort age a. Let d'_a be a "smooth" proportion dead of the same cohort and D'_a be the number of deaths consistent with d'_a, where D'_a is calculated as $(d'_a)(S_a)/(1-d'_a)$. The formula for calculating D'_a is derived from the definition of the smooth proportion dead: $d'_a = D'_a/(D'_a+S_a)$. Now the ratio of the time interval $-a_1$ to $-a_2$, a_2 a_1, is computed as:

$$\sum_{a=a_1}^{a_2} D'_a \div \sum_{a=a_1}^{a_2} D_a$$

where a is an age variable and a_1 and a_2 are years of age at the end of $t=0$ of cohorts born in the latest and the earliest years of the interval, respectively.

When the smooth schedule is a poor approximation of the observed proportions, the segment of the trend that refers to a few years immediately prior to $t=0$ is sawtoothed or kinked and/or one or both ratios differ markedly from unity. The ratio for a particular interval that exceeds (or falls short of) unity results from smooth proportions which on the average exceed (or fall short of) the corresponding observed proportions. Normally, it is necessary to draw a few smooth schedules before the one that approximates observed proportions closely is reached. The ratios implied by this schedule are close to unity and the trend obtained is smooth throughout. The trend is an estimate of the past time path of infant and early childhood mortality.

Use of Aggregated Cohorts

It is possible to save the time and effort entailed in estimating the trends if proportions of aggregated--say, two-year--rather than single-year birth cohorts are used. The use of three- or five-year cohort proportions is possible too. However, in order to control for imprecisions arising from the aggregation itself, estimation for Turkey was based on the proportions of the two-year cohorts.

BIASES ARISING FROM ERRORS IN DATA AND ASSUMPTIONS

The estimates of trends in infant and early childhood mortality based on birth-survival histories may suffer from several errors in data and assumptions. Concerning data inaccuracies, the trend estimates could be biased due to sampling variance and random misreporting of the year of birth, the two causes of data errors discussed earlier. They could also be defective as a result of selective omission of deceased children and misreporting that exaggerates time elapsed since birth.

To offset adverse effects of the sampling variance and the random misreporting, smoothing was incorporated into the estimation. It is fairly likely that under most circumstances smoothing keeps biases associated with these data problems under control. Under special conditions, however, smoothing is not equally useful; for example, when the number of children included in birth-survival histories is very limited and/or when year-of-birth misreporting, although largely random, is particularly pronounced. Under such circumstances, the trend obtained may depend to a considerable degree on the choice of the intervals for which ratios are computed.

Errors in data associated with selective omission of deceased children and year-of-birth misreporting that exaggerates time elapsed since birth affect the trend estimates fully. To the extent these two problems exist, they probably affect more strongly information pertaining to children born longer ago. Hence, it is quite likely that these two causes of data errors, when present, result in proportions dead that rise less steeply than in reality with the cohort year of birth, as it moves backward from the survey year. When the proportions dead are defective in the way just described, infant mortality rates referring to earlier years are downwardly biased and consequently the overall rate of mortality decline is underestimated.

The trend estimation is based on a few implicit assumptions. Whenever the method is applied, two assumptions are used. The first maintains that the age pattern of mortality between ages 0 and 25 to 30 embodied in the Coale-Demeny model family used closely approximates the pattern prevailing in the population for which the estimate is sought. The second assumption postulates no association between the survival of mothers and the mortality of their children.

When the estimation is performed for regional and urban-rural divisions of the national population, two additional assumptions are made. According to the first, effects on the trend estimates arising from transfers of infant and childhood mortality experience across divisional boundaries are minor; the transfers are assumed to be the consequence of pre-survey migration of women. According to the second, transfers of the mortality experience across urban-rural boundaries, which arise from reclassification of communities as their size changes, have negligible effects on trend estimates.

Nonfulfillment of the assumptions leads to biases in the estimates. Thus, when the model and real age patterns of mortality differ, the trend estimate is erroneous. Likewise, when the assumptions on approximate neutrality of transfers of infant and childhood mortality experience are violated, the divisional estimates are bound to be biased. These qualifications of the estimates are discussed in greater detail in Chapter 3 and adjustments are introduced to take the more important biases into account.

Appendix C

Adjustment of the National Censuses for Age Misreporting

Age misreporting is a common defect of censuses, and a variety of methods have been developed to deal with the problem. A procedure suitable for the Turkish censuses was developed by Demeny and Shorter (1968). In recent years, refinements of the method have appeared in the literature, and they are useful for interpreting the age misreporting pattern.

Misreporting consists of raising or lowering one's age, which affects the standard census age distribution by transferring some persons across the boundaries of standard five-year age groups. Das Gupta (1975) applied a model of these transfers to Turkish females in the 1955 and 1960 censuses, and showed that misreporting for females typically consists of upward transfer (Table C-1). Above age 40, age heaping (see glossary) dominates, but it does not stop the persistent upward "slide" that starts from the very youngest age group. The overall pattern is the so-called Asia-Africa one described in Manual IV (United Nations, 1967); it was identified in Turkey by Demeny and Shorter and confirmed by Das Gupta (1975) and Ntozi (1978), each using somewhat different methods.

A fine example of Turkish age exaggeration comes from the 1935 census, which tabulated persons aged 100 years old and over by province. In that census, 2,256 males and 3,985 females claimed to be centenarians. The centenarian rates were approximately 1,000 per million inhabitants in Eastern Turkey and 200 in Western Turkey. An old but reasonably accurate Japanese life table with a life expectation of 42 years for males (similar to that of Turkey in 1935) shows only 2 centenarians per million inhabitants.

TABLE C-1 Proportions of "True" Population of Females in 1955 Transferred Upward or Downward from Five-Year Age Groups by Misreporting: Turkey

Age Group	Population[a] (thousands)		Direction of Transfer	Population Transfers		Proportions of "True" Population Transferred	
	Enumerated	"True"		Up	Down	Up	Down
0-4	1,889	1,970.7	up	81.7	--	.041	--
5-9	1,570	1,531.7	up	43.4	--	.028	--
10-14	1,097	1,113.4	up	59.8	--	.054	--
15-19	1,094	1,167.0	up	32.8	--	.114	--
20-24	1,117	1,131.2	up	47.0	--	.130	--
25-29	1,027	954.1	up	74.1	--	.078	--
30-34	735.1	689.1	up	28.1	--	.041	--
35-39	528.5	515.5	up	15.1	--	.029	--
40-44	624.7	587.3	neither	--	--	--	--
45-49	475.6	544.6	both	46.7	22.3	.086	.041
50-54	531.0	479.4	neither	--	--	--	--
55-59	310.4	383.5	both	68.2	4.9	.178	.013
60-64	389.3	301.1	neither	--	--	--	--
65-69	173.7	216.2	both	22.5	20.0	.104	.093
70-74	172.1	155.2	up	5.6	--	.036	--
75 +	159.3	153.0	neither	--	--	--	--
Total	11,893	11,893					

[a] The population of 1955 is adjusted relative to 1960 for the effect of international migration as required by the correction procedure.

Source: Computed from Das Gupta (1975).

The elegant representation of misreporting achieved by the Das Gupta refinement of the Demeny-Shorter procedure requires elaborate computer work; a different program is required for each sex and every pair of censuses. Comparing Das Gupta's results with those of Demeny-Shorter's original, rather simple method shows that there is little practical difference (Table C-2). Therefore, the simpler approach is preferable for practical applications.

PATTERNS OF AGE ERROR BY SEX

The pattern of age error for Turkish females and males differs markedly, though not in the youngest two age groups. The amount of excess or deficient reporting due to age transfers is shown in Figure C-1 for each age

TABLE C-2 Comparison of Demeny-Shorter (D-S) and P. Das Gupta (PDG) "Corrections" of Age Distributions for Misstatement of Age, Females, 1955 and 1960: Turkey

1960 Census (in thousands)				Size of "Correction" (percents)			
		"Corrected"		1960		1955[a]	
Age Group	Census as Enumerated	D-S	PDG	D-S	PDG	D-S	PDG
0-4	2,079.0	2,159.0	2,169.0	4	4	4	4
5-9	1,928.0	1,892.0	1,892.0	-2	-2	-2	-2
10-14	1,489.0	1,512.0	1,517.0	2	2	1	2
15-19	1,059.0	1,100.0	1,103.0	4	4	7	5
20-24	1,128.0	1,128.0	1,152.0	0	2	1	0
25-29	1,177.0	1,108.0	1,114.0	-6	-5	-7	-6
30-34	985.8	955.7	937.9	-3	-5	-6	-4
35-39	693.8	694.8	676.2	0	-3	-2	0
40-44	548.4	518.9	504.3	-5	-8	-6	-6
45-49	500.0	570.8	572.1	14	14	15	15
50-54	581.2	530.9	526.1	-9	-9	-10	-9
55-59	369.4	450.9	456.5	22	24	24	24
60-64	461.4	359.9	355.6	-22	-23	-23	-23
65-69	213.8	258.5	265.9	21	24	24	24
70-74	195.7	175.7	174.8	-10	-11	-10	-11
75+	182.1	177.3	175.2	-3	-4	-4	-5
Total	13,591	13,591	13,591	0	0	0	0

Note: These "corrections" were in both instances based on the use of "South" model life tables. Subsequent research has shown that split-level "East" models are the best fit to Turkish mortality. Adjustments of age distributions by the panel are based on the "East" models.

[a] Enumerated and corrected data not shown in this table.

Sources: Demeny and Shorter (1968:33, 53-54); Das Gupta (1975:311).

group by selecting a reasonably representative pair of censuses (1955 and 1960) to show the differences by sex. Females are underreported in the range of 10 to 25 years of age and overreported from 25 to 35. This particular vacating of one age range and overreporting of another is probably due to claims of a higher-than-true age immediately after marriage or childbearing. Note that the quantitative amounts of error do not necessarily imply that very large numbers of people misreport age.

Males on the other hand, are attributed ages on a different social basis than females, with the result that they are overreported in the 10-20 age range and underreported from 20 to 30. Some persons apparently claim, or are judged by enumerators, to be below the age

TABLE A-1 Sample Reverse Projection (in thousands) from 1975 (1935-40 not shown): Turkey

FEMALES

AGE	1940	1945	1950	1955	1960	1965	1970	1975
0	1450.9	1318.9	1593.3	1885.7	2324.8	2640.3	2767.7	2652.5
5	1239.2	1275.6	1197.4	1475.9	1771.7	2198.7	2518.3	2665.9
10	970.4	1195.9	1247.8	1188.5	1469.7	1757.8	2177.8	2495.7
15	779.7	942.0	1173.5	1238.2	1183.6	1457.6	1742.3	2160.2
20	493.0	749.3	918.3	1159.5	1227.6	1164.0	1433.3	1713.9
25	750.2	469.3	725.7	904.7	1146.5	1203.0	1132.1	1394.4
30	563.9	708.5	452.6	712.8	893.1	1124.3	1172.4	1098.9
35	557.3	529.6	679.6	443.4	701.5	875.3	1095.7	1141.3
40	490.9	520.6	506.0	661.1	435.2	685.9	850.1	1065.8
45	445.6	455.9	494.6	490.1	643.2	423.4	665.3	826.0
50	409.0	407.2	427.4	473.2	472.4	619.9	409.5	645.3
55	369.9	360.4	371.4	400.0	447.3	447.9	591.2	392.3
60	320.9	306.0	313.5	334.7	365.9	411.6	415.8	551.8
65	268.8	239.8	246.3	264.9	289.0	319.4	363.8	370.4
70	184.2	172.6	170.9	187.1	207.4	230.2	258.8	298.0
75+	160.2	145.6	155.6	173.2	199.4	230.1	266.3	308.1
TOT	9454.1	9797.3	10673.9	11992.8	13778.2	15789.3	17860.5	19780.5

MALES

AGE	1940	1945	1950	1955	1960	1965	1970	1975
0	1460.9	1391.4	1665.8	2007.1	2492.2	2885.5	2905.3	2765.2
5	1371.7	1280.5	1258.8	1538.6	1882.5	2352.0	2749.1	2795.7
10	1115.3	1328.7	1255.9	1252.0	1534.8	1870.7	2331.3	2728.7
15	826.3	1087.1	1306.5	1248.2	1247.8	1524.1	1854.4	2314.2

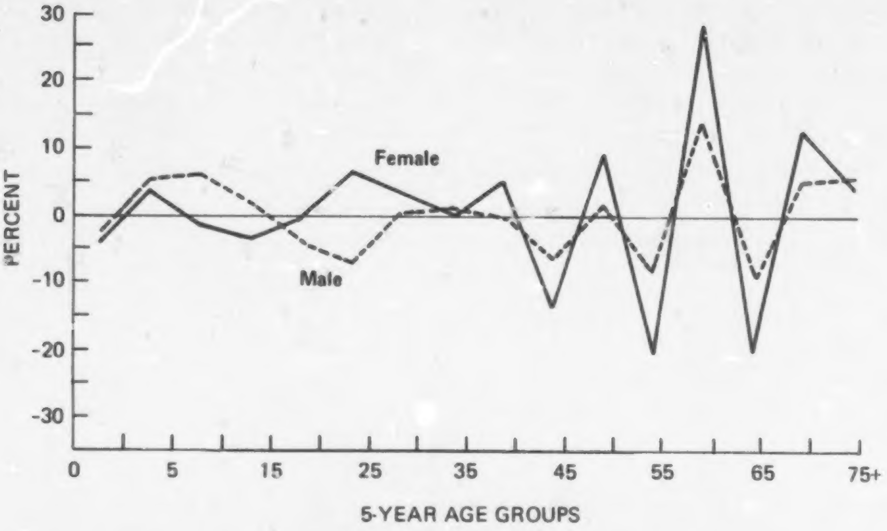


FIGURE C-1 Age Errors by Sex: Difference Between Enumerated and Corrected Population by Five-Year Age Groups: Turkey (excess as percent of corrected)

Source: For 1955-60 pair of census, see Tables 1 and C-3.

of military service (about age 20), or marriage (mid-20s) until these events actually occur. This causes many males to be reported at a lower age when they are actually in the 20-30 range, thus depleting the number reported in the upper range. At the upper end of the 20-30 range, some men may well be reported at ages above 30 if they are married. Males typically marry in their mid- and late 20s and thereafter become known as 30 or above even if they are not in fact that old.

Age heaping on tens above age 40 is stronger for females than males, suggesting that female age reporting is generally less accurate than male reporting.

AGE CORRECTIONS FOR 1935-75

The Demeny-Shorter method was applied to all pairs of censuses from 1935-40 to 1970-75. The method works well for the period from 1935 to 1960. Thereafter, out-migration was substantial and age errors in the migration data cause errors in the estimated correction factors themselves. The pattern of age errors detected for each sex is stable over the 1935-60 period, with a slight trend toward reduced magnitude in general. The corrections for 1935 to 1960 were carried out, therefore, by fitting a linear trend to the age correction factors for each age group between 1935-40 and 1955-60. The factors were then held constant after 1960. The corrected national age distributions are shown in Table C-3 and Figure C-2.

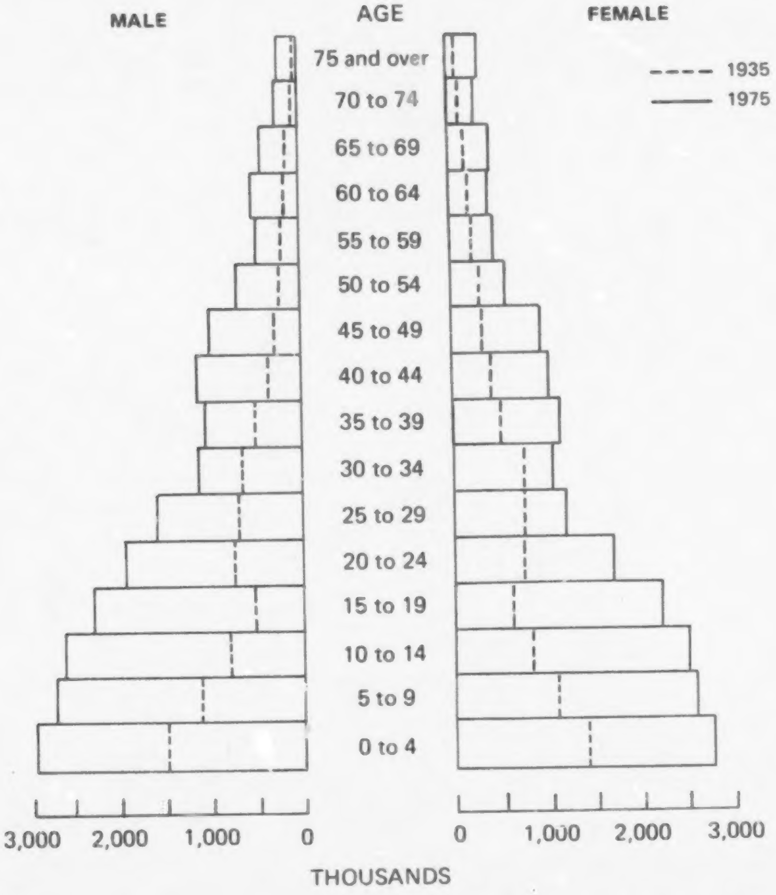


FIGURE C-2 Population by Age and Sex Corrected for Age Misreporting, 1935 and 1975: Turkey

Source: Table C-3.

TABLE C-3 Population (in thousands) by Age and Sex, Corrected for Age Misreporting, 1935-75: Turkey

Age	1935[a]	1940	1945	1950	1955	1960	1965	1970	1975[b]
Males									
0-4	1,486.0	1,427.0	1,331.0	1,638.0	2,053.0	2,270.5	2,462.5	2,775.4	2,882.0
5-9	1,122.0	1,312.0	1,261.0	1,258.0	1,587.0	1,987.0	2,323.0	2,505.0	2,681.1
10-14	802.1	1,115.0	1,210.0	1,201.0	1,221.0	1,601.1	1,958.7	2,243.8	2,589.5
15-19	541.5	798.9	1,018.0	1,235.0	1,217.0	1,228.3	1,527.6	1,896.9	2,279.6
20-24	767.2	533.4	809.1	1,017.0	1,245.0	1,221.6	1,262.5	1,556.0	1,905.1
25-29	691.3	748.3	528.2	785.9	1,030.0	1,238.3	1,134.8	1,188.9	1,557.4
30-34	647.4	663.6	770.6	538.5	751.7	1,011.6	1,126.1	1,005.5	1,077.4
35-39	519.4	614.1	624.2	694.1	514.9	733.0	980.6	1,095.6	1,013.7
40-44	348.0	489.0	562.6	562.3	668.5	501.3	701.9	915.6	1,087.6
45-49	263.2	324.6	430.5	533.2	558.5	650.6	477.4	689.1	965.3
50-54	222.7	242.3	277.4	381.1	494.2	538.5	604.2	450.0	644.1
55-59	186.7	197.7	192.1	237.5	358.9	463.3	492.9	543.7	425.1
60-64	146.0	158.9	169.9	169.3	211.4	326.1	402.2	422.2	458.4
65-69	117.3	114.5	111.9	127.8	139.1	181.6	282.8	351.8	386.4
70-74	89.7	80.5	77.3	74.0	93.6	107.8	138.6	209.7	248.6
75+	79.5	79.7	71.7	75.4	90.3	103.3	121.2	157.9	215.8
Subtotal	8,030	8,899	9,447	10,527	12,233	14,164	15,997	18,007	20,417

Appendix D
International Migration

Data on international migration are required for several of the procedures used in this report: estimating crude birth rates by multiple reverse projections (Chapter 2), estimating mortality above age 5 by forward projection (Chapter 3); and adjusting the censuses for age misreporting (Appendix C). Available data were used, therefore, to establish estimates of the net balance of migration and its distribution by sex and age.

MIGRATION VOLUME

The censuses of West Germany enumerate population by national origin. These censuses, reports by the Labor Bureau in Turkey, and special studies of the State Planning Organization based on Turkish consular surveys and other sources, were used to formulate the migration estimates from 1960 to 1975. For 1935 to 1960, volume estimates by Turkish scholars are available (Geray, 1962; Turkay, 1962).

Censuses of destination countries such as West Germany are particularly useful in making migration estimates, because they keep track of the stock of Turks living abroad. Two-way circulation with the home country shows up as changes in this stock after allowance for natural increase. To illustrate how this estimation procedure works, the use of the West German censuses to estimate the net flow during 1970-75 is explained below.

The Turkish population in West Germany increased from 429.4 thousand in May 1970 to 1,079.3 thousand at the end of September 1976. (Data for the exact five-year period, 1970-75, are not available.) This change amounts to an annual rate of increase of 14.5 percent. Births to

Turkish parents living in Germany (both parents Turks) were 161.4 thousand, implying a crude birth rate among the migrants of 43 per thousand. Since the death rate presumably is low (perhaps about 8), natural increase may be assumed to be 3.5 percent. A population increase of 11 percent (14.5 percent less 3.5 percent) due to migration implies the volume of Turkish migration to Germany during the five years from October 1970 to October 1975. To calculate the growth of the migrant population over the five-year period, the following equation is used:

$$P_1 = P_o(e^{rt})$$

where P_1 is the population to be estimated, P_o is the original population, r is the yearly rate of growth, and t is time elapsed (years) between the dates of P_o and P_1.

Size of Migrant Stock	Thousands
Oct. 1970: 429.4 $e^{(.145)(.5)}$	461.7
Oct. 1975: 429.4 $e^{(.145)(5.5)}$	953.3
Change in size over five years	+491.6
Allocate 11.0/14.5 to migration	372.9
Balance due to natural increase	118.7

A second source of information is annual data from West Germany on migrant movements themselves. These data, shown below, justify a five-year net migration estimate of 300 to 400 thousand:

Year	Net Migrants (thousands)
1971	+126.4
1972	not available
1973	+162.8
1974	+ 50.0
1975	- 49.9

An upward bias may exist in these particular data because they are described as including "short-term" in-migrants. The out-migrant data, on the other hand, are deletions from local population registers where Turks have registered their residence.

Allowing a margin for net migration to other countries, and for demographic growth of the net migrant flow after arrival abroad, the demographic effect on the Turkish population in Turkey for 1970-75 is estimated at a loss of 400 thousand persons. This estimate, taken together with estimates from other sources for other dates, provides the series shown in the last column of Table D-1.

The distribution of migrants by sex and age for the years since 1960 is found in a sample survey by Abadan (1964), the censuses of the Federal Republic of Germany, and Turkish consular reports collected and analyzed by

TABLE D-1 Demographic Effect of International Migration on National Population Size, 1935-75: Turkey

Intercensal Period of Migration	Change in National Population (thousands)		
	Males	Females	Total
1935-40	67.3	67.5	134.8
1940-45	12.6	12.4	25.0
1945-50	18.6	18.4	37.0
1950-55	77.8	75.2	153.0
1955-60	73.5	70.5	144.0
1960-65	-161.8	-37.8	-199.6
1965-70	-256.0	-114.6	-370.6
1970-75	-248.0	-152.0	-400.0

Note: The demographic effect of migration at the end of a five-year period of migration differs from the actual number who migrate during the period, because the migrant population continues to change with natural increase between the dates of migration and the second census date of the period.

Sources: Estimates for 1935-60 are based on Geray (1962) and Turkay (1962). For 1960-70, estimates are from the State Planning Organization. The 1970-75 estimate is from an analysis of the census and vital statistics of the Federal Republic of Germany and from information on the pattern of destinations in prior years.

the State Planning Organization. For periods prior to 1960, international migration was chiefly whole families, because it was relocation of population. A reasonable assumption is that migration up to 1960 had the same sex and age distribution as the Turkish population.

The estimates that provide the assumptions for the multiple reverse projections of Chapter 2 are shown in Tables D-2 and D-3. Adjustments for age misreporting and the estimation of mortality above age 5 make use of the material in Table D-1.

The migration data are useful as intermediate estimates for other calculations, even though they are subject to considerable possibilities for error. The methods used to estimate fertility and mortality were handled with an awareness of the extent of error introduced by migration error. Judgment based on general knowledge of the Turkish situation has been used to accept some implications and not others.

TABLE D-2 Average Yearly International Migration for Intercensal Periods, 1935-75: Turkey

	Net Migration (thousands)		
Period	Males	Females	Total
1935-40	12.8	12.9	25.7
1940-45	2.4	2.3	4.7
1945-50	3.5	3.4	6.9
1950-55	14.3	13.8	28.1
1955-60	13.7	13.2	26.9
1960-65	-30.3	- 7.1	-37.4
1965-70	-47.8	-21.4	-69.2
1970-75	-46.5	-28.5	-75.0

TABLE D-3 Distribution of Net International Migration by Age, for Each Sex, 1960-75: Turkey

	1960-65		1965-75	
Age Group	Males	Females	Males	Females
0-4	5.2	21.4	4.4	9.5
5-9	2.2	9.0	4.6	9.4
10-14	-1.2	-4.5	3.9	7.6
15-19	1.1	13.0	0.5	3.3
20-24	20.5	30.2	4.8	20.6
25-29	40.2	21.4	26.8	17.7
30-34	19.4	9.0	26.8	13.7
35-39	9.1	4.2	16.0	10.6
40-44	2.9	1.1	9.7	8.4
45-49	1.6	0.8	3.5	1.2
50-54	-0.4	-1.3	-0.3	-0.5
55-59	-0.2	-1.1	-0.2	-0.4
60-64	-0.2	-1.3	-0.2	-0.4
65-69	-0.1	-0.8	-0.1	-0.3
70-74	-0.0	-0.5	-0.1	-0.2
75+	-0.0	-0.5	-0.0	-0.2
Total	100.0	100.0	100.0	100.0

Appendix E
Population by Six Divisions by Age and Sex, 1945-70

TABLE E-1 Population of Six Divisions by Age and Sex as Reported in the Censuses, 1945-70: Turkey[a]

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part A	1945						
Males							
0-4	36,917	41,900	78,949	395,816	416,395	318,378	1,288,355
5-9	38,388	44,888	85,383	424,906	437,495	319,078	1,350,138
10-14	45,774	51,471	89,755	424,415	413,602	261,523	1,286,540
15-19	64,117	57,064	94,640	341,004	305,360	187,794	1,049,979
20-24	78,613	88,732	124,208	252,073	124,759	121,620	790,005
25-29	39,791	31,612	47,815	154,439	120,546	90,695	484,898
30-34	53,597	43,629	63,731	254,561	203,634	112,995	732,147
35-39	42,011	34,702	49,134	216,404	170,736	95,098	608,085
40-44	35,045	30,278	43,236	193,174	153,045	88,175	542,953
45-49	32,821	24,943	34,015	140,803	102,784	66,475	401,841
50-54	24,583	16,988	23,606	86,851	68,229	62,934	283,191
55-59	18,313	12,640	13,979	59,729	36,602	30,086	171,349
60-64	17,768	11,334	15,777	58,182	46,181	50,896	200,138
65+	24,578	15,893	18,079	85,493	58,304	54,620	256,967
Total	552,316	506,074	782,307	3,087,849	2,657,675	1,860,363	9,446,584
Females							
0-4	36,546	40,351	72,585	375,792	383,100	278,173	1,186,547
5-9	37,609	43,820	80,811	403,697	402,375	275,768	1,244,080
10-14	42,466	46,751	78,339	370,285	[illegible]7,495	200,263	1,075,599
15-19	52,722	46,974	73,702	321,772	275,483	162,094	932,747
20-24	47,537	35,363	55,711	221,194	194,233	138,608	692,646
25-29	33,767	25,602	43,532	195,388	193,413	128,257	619,959
30-34	42,428	31,697	50,784	229,827	213,470	132,442	700,648
35-39	39,783	29,720	46,941	199,696	169,498	93,556	579,194
40-44	35,229	27,049	41,626	182,625	163,731	108,518	558,778
45-49	32,207	22,507	28,822	138,723	103,347	53,399	379,005
50-54	28,806	20,479	29,464	140,420	129,665	85,873	434,707
55-59	22,412	14,823	15,514	87,750	53,582	25,602	219,683
60-64	22,375	16,756	23,316	119,748	104,391	63,092	349,678
65+	32,751	23,861	24,737	141,059	92,259	55,662	370,329
Total	506,638	425,753	665,884	3,127,970	2,816,039	1,801,309	9,343,593

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part B 1950							
Males							
0-4	51,123	57,768	102,165	479,374	504,149	390,542	1,585,121
5-9	47,999	53,142	92,025	404,788	417,761	322,823	1,338,538
10-14	46,063	51,591	88,788	400,441	405,436	283,253	1,275,572
15-19	73,033	60,490	98,020	400,668	385,181	253,943	1,271,335
20-24	85,009	76,805	131,902	291,041	228,648	177,478	990,883
25-29	54,547	26,828	53,682	251,731	190,636	149,606	727,030
30-34	50,047	49,724	57,592	140,459	124,257	102,236	524,315
35-39	44,964	42,810	52,735	244,674	192,124	111,113	688,420
40-44	47,367	31,989	50,390	187,206	150,145	84,878	551,975
45-49	36,174	31,057	39,901	176,251	134,652	81,765	499,800
50-54	27,625	22,586	29,839	139,588	106,826	63,142	389,606
55-59	19,710	12,142	15,059	69,763	49,749	47,877	214,300
60-64	17,978	15,627	16,678	59,849	44,316	42,637	197,085
65+	27,360	19,215	19,840	85,159	60,644	60,883	273,101
Total	628,999	551,774	848,616	3,331,000	2,994,523	2,172,177	10,527,089
Females							
0-4	49,872	57,730	97,766	461,487	483,081	359,327	1,509,263
5-9	46,488	52,998	88,608	381,115	388,523	280,598	1,238,330
10-14	44,099	50,170	80,713	350,108	339,463	217,598	1,082,151
15-19	53,871	55,178	82,013	369,687	346,503	212,423	1,119,675
20-24	58,974	51,116	75,552	307,322	286,422	194,772	974,158
25-29	44,082	29,013	52,420	236,532	226,637	163,898	752,582
30-34	41,326	38,895	50,993	163,055	171,474	125,573	591,316
35-39	42,350	36,501	47,255	196,536	175,302	102,793	600,737
40-44	43,642	31,069	47,191	198,486	174,704	100,854	595,946
45-49	34,907	27,186	32,610	148,641	126,240	76,216	445,800
50-54	34,075	26,192	34,999	162,872	134,917	78,990	472,045
55-59	21,541	15,252	16,351	91,029	71,489	44,838	260,500
60-64	27,997	22,953	26,424	125,309	97,797	58,731	359,211
65+	38,396	30,635	29,045	153,631	104,606	62,067	418,380
Total	581,620	524,888	761,940	3,345,815	3,127,159	2,078,682	10,420,104

Females									
0-4	1,399.0	1,328.0	1,245.0	1,574.0	1,962.0	2,163.4	2,356.4	2,693.2	2,752.0
5-9	1,074.0	1,192.0	1,176.0	1,174.0	1,498.0	1,867.2	2,181.1	2,399.7	2,574.5
10-14	809.3	1,044.0	1,117.0	1,106.0	1,106.0	1,496.9	1,822.2	2,173.7	2,502.2
15-19	563.1	780.2	1,018.0	1,194.0	1,141.0	1,091.7	1,407.4	1,820.1	2,219.7
20-24	683.7	538.3	709.3	983.7	1,115.0	1,123.0	1,129.3	1,346.0	1,701.2
25-29	680.1	655.7	575.9	698.9	956.2	1,107.4	1,093.3	1,082.6	1,307.6
30-34	590.0	656.0	649.9	554.7	699.2	959.8	1,105.7	1,131.9	1,066.7
35-39	515.2	566.4	577.0	598.0	527.6	700.5	944.6	1,105.0	1,148.9
40-44	442.3	490.5	519.4	557.0	588.0	525.2	648.9	859.6	1,017.6
45-49	386.4	416.4	448.0	520.8	550.4	578.4	497.4	650.8	952.6
50-54	332.2	359.9	381.2	419.8	479.8	538.3	548.0	472.1	596.1
55-59	278.6	297.4	292.8	337.5	391.8	458.0	515.1	544.8	484.5
60-64	213.3	236.0	257.3	269.4	298.2	363.8	395.9	416.8	433.3
65-69	159.3	164.0	172.1	203.8	219.7	261.2	331.6	389.2	451.2
70-74	101.8	106.8	111.0	117.8	150.2	176.4	199.2	238.7	267.9
75+	89.3	90.3	94.2	111.1	148.3	179.7	217.9	268.9	303.1
Subtotal	8,317	8,922	9,344	10,420	11,831	13,591	15,394	17,598	19,780
Total	16,347	17,821	18,790	20,947	24,065	27,755	31,391	35,605	40,198

---

[a] Includes province of Hatay, annexed in 1939.
[b] Preliminary: estimated from a one percent sample of the 1975 census.

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part C 1955							
Males							
0-4	77,909	85,441	164,721	558,347	610,046	489,040	1,985,504
5-9	67,679	79,421	148,881	485,189	503,988	391,878	1,677,036
10-14	62,405	68,055	122,250	383,616	382,733	276,749	1,295,808
15-19	97,437	75,322	138,168	356,702	333,466	247,160	1,248,255
20-24	117,603	135,143	227,681	295,676	224,347	209,753	1,210,203
25-29	97,519	69,301	117,198	288,674	230,292	156,500	959,484
30-34	72,323	57,518	85,221	223,471	171,091	139,413	749,037
35-39	45,525	36,411	56,518	148,826	132,841	99,331	519,452
40-44	57,160	47,787	69,572	215,298	176,704	100,254	666,775
45-49	44,183	37,626	50,224	184,462	135,671	72,843	525,009
50-54	35,939	32,431	45,045	173,405	138,896	79,650	505,366
55-59	29,372	23,896	30,550	113,048	81,641	48,717	327,224
60-64	20,125	15,767	21,102	69,872	57,772	58,415	243,053
65+	32,256	23,586	27,291	97,629	68,305	72,138	321,205
Total	857,435	787,705	1,304,422	3,594,215	3,247,801	2,441,841	12,233,419
Females							
0-4	69,795	80,694	151,808	540,869	588,189	448,010	1,879,365
5-9	64,412	76,304	140,675	459,561	473,412	347,622	1,561,986
10-14	54,084	61,212	101,603	344,163	320,223	209,301	1,090,586
15-19	59,249	61,979	102,166	341,221	319,146	204,346	1,088,107
20-24	66,601	64,197	104,925	334,571	318,692	222,113	1,111,099
25-29	68,063	59,063	95,831	303,483	296,589	198,621	1,021,650
30-34	53,007	44,458	69,385	210,911	200,563	152,963	731,287
35-39	39,803	32,835	52,764	157,142	145,743	97,553	525,840
40-44	46,788	37,467	56,715	194,363	176,153	110,059	621,545
45-49	41,482	32,472	44,433	164,177	126,302	64,261	473,127
50-54	38,407	30,804	44,839	169,519	150,464	94,174	528,207
55-59	31,264	24,378	27,627	114,837	75,430	35,237	308,773
60-64	27,311	22,835	30,951	124,673	109,832	71,684	387,286
65+	47,629	38,118	41,107	181,979	121,598	72,056	502,487
Total	707,895	666,816	1,064,829	3,641,471	3,422,333	2,327,999	11,831,343

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part D 1960							
Males							
0-4	87,964	124,784	225,878	578,497	651,961	515,622	2,184,706
5-9	86,656	126,238	223,95[illegible]	553,824	604,831	481,354	2,076,854
10-14	82,458	116,801	198,568	453,532	475,720	364,111	1,691,190
15-19	107,246	112,258	184,880	320,203	296,749	228,606	1,249,942
20-24	108,123	182,638	258,351	249,481	200,786	178,851	1,178,230
25-29	108,414	107,167	159,001	319,563	273,856	189,521	1,157,522
30-34	94,291	94,845	139,312	287,012	247,523	165,325	1,028,308
35-39	69,746	71,998	96,030	214,840	168,756	128,338	749,708
40-44	43,963	43,687	62,004	134,165	125,445	96,721	505,985
45-49	54,822	56,515	71,303	196,253	153,667	77,877	610,437
50-54	43,668	45,053	55,196	179,073	142,304	83,178	548,472
55-59	32,611	35,623	43,142	149,752	110,794	52,800	424,722
60-64	27,262	27,481	35,075	112,332	94,162	72,647	368,959
65+	38,014	35,191	38,394	112,685	83,371	81,202	388,857
Total	985,238	1,180,279	1,791,085	3,861,201	3,629,928	2,716,158	14,163,889
Females							
0-4	84,227	120,827	214,287	557,045	625,511	477,026	2,078,923
5-9	82,240	120,398	209,603	525,216	561,931	428,285	1,927,673
10-14	73,160	102,663	164,507	425,792	423,845	298,547	1,488,514
15-19	68,128	84,127	126,921	307,004	282,724	190,334	1,059,230
20-24	73,957	84,551	134,576	313,377	300,953	220,440	1,127,854
25-29	75,666	85,614	133,055	330,330	331,804	220,846	1,177,315
30-34	71,336	76,943	113,237	274,183	266,901	183,190	985,790
35-39	57,915	60,780	83,098	200,790	173,908	117,273	693,764
40-44	39,283	38,608	59,040	147,147	152,608	111,745	548,431
45-49	46,222	43,328	55,396	161,938	128,675	64,423	499,982
50-54	43,634	41,551	57,362	177,159	159,238	102,376	581,320
55-59	36,062	34,093	39,080	128,645	89,690	41,860	369,430
60-64	33,008	33,207	43,601	142,949	125,047	83,558	461,367
65+	57,288	55,395	56,058	205,013	136,215	81,373	591,342
Total	842,126	982,085	1,489,821	3,896,578	3,759,048	2,621,274	13,590,932

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part E 1965							
Males							
0-4	100,684	150,141	304,989	566,996	685,907	550,623	2,359,340
5-9	110,463	168,269	315,207	593,197	682,567	549,137	2,418,840
10-14	105,638	165,479	290,501	517,076	550,899	431,493	2,061,086
15-19	142,907	162,003	273,437	364,024	340,388	265,850	1,548,609
20-24	112,222	207,775	287,033	240,384	185,395	180,272	1,213,081
25-29	103,584	113,934	175,547	271,641	222,934	169,081	1,056,721
30-34	103,677	118,016	179,634	297,011	259,556	182,513	1,140,407
35-39	91,308	105,601	154,597	265,542	226,994	155,106	999,148
40-44	67,458	76,257	101,607	190,792	149,277	120,409	705,800
45-49	43,145	46,131	62,094	120,089	101,401	73,355	446,215
50-54	54,082	59,563	76,034	186,793	151,222	85,430	613,124
55-59	39,070	44,085	51,841	152,431	110,491	52,291	450,209
60-64	29,199	35,712	47,080	140,905	121,088	79,495	453,479
65+	46,073	49,952	57,960	156,303	121,987	98,628	530,903
Total	1,149,510	1,502,918	2,377,561	4,063,184	3,910,110	2,993,681	15,996,964
Females							
0-4	95,815	144,857	289,204	550,152	664,517	520,287	2,264,832
5-9	105,701	161,090	294,223	564,567	640,069	486,617	2,252,267
10-14	95,525	145,026	242,742	483,551	494,419	351,033	1,812,296
15-19	95,208	124,630	198,813	366,054	346,223	234,837	1,365,765
20-24	84,506	100,807	164,427	286,934	281,261	216,586	1,134,521
25-29	80,676	100,981	162,749	294,523	305,365	218,260	1,162,554
30-34	79,000	99,631	151,795	297,836	300,208	207,464	1,135,934
35-39	77,149	90,495	133,234	256,489	230,730	147,712	935,809
40-44	57,294	62,364	86,930	181,310	164,985	124,780	677,663
45-49	39,490	40,658	55,619	122,487	105,736	66,131	430,121
50-54	48,711	49,707	68,435	173,920	154,557	96,315	591,645
55-59	41,137	41,960	49,708	138,416	99,065	45,331	415,617
60-64	36,503	40,637	55,618	151,860	133,284	84,184	502,086
65+	68,379	73,569	78,014	236,567	164,051	92,758	713,338
Total	1,005,094	1,276,412	2,031,511	4,014,677	4,084,472	2,892,291	15,394,457

TABLE E-1 (continued)

	Urban			Rural			
	Istanbul Izmir	Other West	Central East	West	Central	East	National
Part F 1970							
Males							
0-4	134,208	233,596	432,755	559,660	692,281	609,221	2,661,721
5-9	134,688	213,996	443,357	553,484	680,894	584,572	2,610,991
10-14	151,154	234,356	435,943	522,212	568,046	451,730	2,363,441
15-19	189,172	241,424	411,060	397,130	375,049	310,851	1,924,686
20-24	163,945	254,663	388,990	267,685	219,179	202,173	1,496,635
25-29	134,295	148,803	227,458	238,936	201,176	157,531	1,108,199
30-34	105,270	133,219	197,970	233,491	194,369	154,856	1,019,175
35-39	107,746	136,433	204,674	272,292	233,238	162,993	1,117,376
40-44	93,088	116,626	165,111	230,735	184,819	131,102	921,481
45-49	69,551	80,785	107,290	172,115	123,852	91,152	644,745
50-54	45,068	50,381	72,120	114,589	98,630	76,302	457,090
55-59	50,284	55,351	72,190	153,784	114,212	51,230	497,051
60-64	37,749	45,402	60,368	141,793	116,172	74,971	476,455
65+	57,754	70,890	91,760	209,621	166,828	111,087	707,940
Total	1,473,972	2,015,925	3,311,046	4,067,527	3,968,745	3,169,771	18,006,986
Females							
0-4	129,763	203,102	404,356	553,412	699,839	604,299	2,594,771
5-9	130,890	190,269	410,243	546,750	662,433	543,390	2,483,975
10-14	131,816	209,807	366,971	516,283	552,171	390,207	2,167,255
15-19	131,666	187,609	312,455	425,722	418,782	294,485	1,770,719
20-24	123,771	149,271	251,801	307,093	296,636	226,958	1,355,530
25-29	100,552	123,324	208,378	260,745	264,127	196,827	1,153,953
30-34	91,238	133,009	200,247	263,112	276,986	201,117	1,165,709
35-39	93,105	121,622	187,426	277,336	253,631	164,136	1,097,256
40-44	83,244	100,198	146,586	228,122	203,352	138,452	899,954
45-49	60,964	64,242	88,454	154,742	118,519	77,214	564,135
50-54	43,746	50,477	75,652	130,138	125,045	91,267	516,325
55-59	47,421	48,107	62,661	135,221	99,862	47,304	440,576
60-64	43,836	49,731	72,858	151,162	130,523	81,825	529,935
65+	82,332	95,697	113,782	267,021	193,277	105,988	858,097
Total	1,294,344	1,726,465	2,901,870	4,216,859	4,295,183	3,163,469	17,598,190

[a] Persons with ages reported unknown are redistributed in proportion to the number of persons in each age group.

Glossary

AGE HEAPING A tendency for enumerators or respondents to report certain ages instead of others; also called age preference or digit preference. Preference for ages ending in 0 or 5 is widespread.

AGE PATTERN OF FERTILITY The relative distribution of a set of age-specific fertility rates. It expresses the relative contribution of each age group to total fertility.

AGE RATIO The ratio of the population in a given age group to the average of the populations in the two neighboring age groups, times 100.

AGE-SPECIFIC FERTILITY RATE The number of births occurring during a specified period to women of a specified age or age group, divided by the number of person-years-lived during that period by women of that age or age group. When an age-specific fertility rate is calculated for a calendar year, the number of births to women of the specified age is usually divided by the midyear population of women of that age.

AGE-SPECIFIC MORTALITY RATE The number of deaths occurring during a specified period to persons (usually specified by sex) of a specified age or age group, divided by the number of person-years-lived during that period by the persons of that age or age group. When an age-specific mortality rate is calculated for a calendar year, the number of deaths to persons of the specified age is usually divided by the midyear population of persons of that age. Age-specific mortality rates are generally denoted by ${}_nM_x$, the annual death rate to persons aged x to x + n.

AGE STANDARDIZATION A procedure of adjustment of crude rates (birth, death, or other rates) designed to reduce the effect of differences in age structure when comparing rates for different populations.

BIRTH HISTORY A report of the number and dates of all live births experienced by a particular woman; see also pregnancy history. The sex of each child, the survival of each child to the date of the interview, and, where pertinent, the date of death are also generally recorded.

BIRTH ORDER The ordinal number of a given live birth in relation to all previous live births of the same woman (e.g., 5 is the birth order of the fifth live birth occurring to the same woman).

BIRTH RATE See crude birth rate.

CHANDRASEKARAN-DEMING TECHNIQUE A procedure to estimate the coverage of two independent systems collecting information about demographic or other events, based on the assumption that the probability of an event being recorded by one system is the same whether or not the event is recorded by the other system. The events from both systems are matched to establish M, the number of events recorded by both systems; U_1, the number recorded only by system 1; and U_2, the number recorded only by system 2. The Chandrasekaran-Deming formula then estimates total events, N, as

$$\hat{N} = M + U_1 + U_2 + \frac{U_1 U_2}{M}.$$

CHILDBEARING AGES The span within which women are capable of bearing children, generally taken to be from age 15 to age 49 or, sometimes, to age 44.

CHILDREN EVER BORN(E) The number of children ever borne alive by a particular woman; synonymous with parity. In demographic usage, stillbirths are specifically excluded.

COHORT A group of individuals who experienced the same class of events in the same period. Thus an age cohort is a group of people born during a particular period, and a marriage cohort is a group of people who married during a particular period. The effects of a given set of mortality or fertility rates are often illustrated by applying them to hypothetical cohorts.

COHORT FERTILITY The fertility experienced over time by a group of women or men who form a birth or a marriage cohort. The analysis of cohort fertility is contrasted with that of period fertility.

CRUDE BIRTH RATE The number of births in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as births per 1,000 population. The crude birth rate for a single year is usually calculated as the number of births during the year divided by the midyear population.

CRUDE DEATH RATE The number of deaths in a population during a specified period divided by the number of person-years-lived by the population during the same period. It is frequently expressed as deaths per 1,000 population. The crude death rate for a single year is usually calculated as the number of deaths during the year divided by the midyear population.

CUMULATED FERTILITY An estimate of the average number of children ever borne by women of some age x, obtained by cumulating age-specific fertility rates up to age x; also often calculated for age groups.

DEATH RATE See crude death rate.

DE FACTO POPULATION A population enumerated on the basis of those present at a particular time, including temporary visitors and excluding residents temporarily absent. See de jure population.

DE JURE POPULATION A population enumerated on the basis of normal residence, excluding temporary visitors and including residents temporarily absent. See de facto population.

DIGITAL PREFERENCE See age heaping.

DUAL RECORD SYSTEM See Chandrasekaran-Deming Technique

EXPECTATION OF LIFE AT BIRTH The average number of years that a member of a cohort of births would be expected to live if the cohort were subject to the mortality conditions expressed by a particular set of age-specific mortality rates. Denoted by the symbol e(o) in life table notation.

FERTILITY HISTORY Either a birth history or a pregnancy history.

FORWARD SURVIVAL A procedure for estimating the age distribution at some later date by projecting forward an observed age distribution. The procedure uses survival ratios, often obtained from model life tables. The procedure is basically a form of population projection without the introduction of new entrants (births) to the population.

GENERAL FERTILITY RATE The ratio of the number of live births in a period to the number of person-years-lived by women of childbearing ages during the period. The general fertility rate for a year is usually calculated as the number of births divided by the number of women of childbearing ages at midyear.

GROSS REPRODUCTION RATE The average number of female children a woman would have if she survived to the end of her childbearing years and if, throughout, she were subject to a given set of age-specific fertility rates and a given sex ratio at birth. This number provides a measure of replacement fertility in the absence of mortality.

GROWTH RATE The increase or decrease of a population in a period divided by the number of person-years-lived by the population during the same period. The increase in a population is the result of a surplus (or deficit) of births over deaths and a surplus (or deficit) of immigrants over emigrants. (The annual increase is often expressed as a fraction of the total population at the beginning of the year, but this convention has the inconvenient characteristic of not being readily defined for a five-year interval and of being unequal to the difference between the birth rate and the death rate even in the absence of migration.) See also rate of natural increase.

INFANT MORTALITY RATE The number of deaths of children under 1 year of age occurring in the same year; also used in a more rigorous sense to mean the number of deaths that would occur under 1 year of age in a life table with a radix of 1,000, in which sense it is denoted by the symbol ${}_1q_0$.

LIFE TABLE A listing of the number of survivors at different ages (up to the highest age attained) in a hypothetical cohort subject from birth to a particular set of age-specific mortality rates. The rates are usually those observed in a given population during a particular period of time. The survivors of the radix to age x are generally denoted by $l(x)$. The tabulations commonly accompanying a life table include other features of the cohort's experience: its expectation of life at each age x, denoted by $e(x)$; the probability of surviving from each age x to age x + n, denoted by ${}_nq_x$; the person-years-lived by the hypothetical cohort as it ages from age x to age x + n, denoted by ${}_nL_x$ (also equivalent to the population aged x, x + n in a stationary population experiencing a number of births each year equal to the radix of the life table); and the person-years-lived by the hypothetical cohort from age x onward, denoted by T(x).

LOGIT The logit of a proportion p is 1/2 ln[p/(1 - p)]. As a linearizing transformation, the logit has been proposed as the basis of a model life table system in which the logit of a probability of dying by age x $({}_xq_0)$ is related linearly to the logit of a standard probability of dying by age x $({}_xq_0^s)$ so that

$$\text{logit }({}_xq_0) = \alpha + \beta\ [\text{logit }({}_xq_0^s)],$$

where α is a measure of mortality level relative to the standard and β is a parameter that alters the shape of the standard mortality function.

MARITAL FERTILITY Any measure of fertility in which the births (in the numerator) are births to married women and in which the number of person-years-lived (in the denominator) also pertains to married women. In some instances, the designation "married" includes persons in consensual unions.

MEDIAN The value associated with the central member of a set that is ordered by size or some other characteristic expressed in numbers.

MEAN AGE OF CHILDBEARING The average age at which a mortality-free cohort of women bear their children according to a set of age-specific fertility rates.

MEAN AGE OF CHILDBEARING IN THE POPULATION The average age of the mothers of the children born in a population during a year. This measure incorporates the effects of both mortality and the age distribution.

MIGRATION RATE Number of migrants during a specified period divided by the person-years-lived of the population exposed to migration. Also see population change due to migration.

MODEL LIFE TABLE An expression of typical mortality experience derived from a group of observed life tables.

MOVING AVERAGES The successive averaging of two or more adjacent values of a series in order to remove sharp fluctuations.

MYERS INDEX An index of digit preference that essentially sums in turn the population ending in each digit over some age range, often 10-89, expressing the total as a percentage of the total population, and which avoids the bias introduced by the fact that the population is not evenly distributed among all ages by repeating the calculations 10 times, once for each starting digit, and averaging the results. The difference between the average percentage for each digit and the expected value of 10 percent provides a measure of the preference for or avoidance of the digit over the age range considered.

NATURAL FERTILITY The age pattern of marital fertility observed in non-contraceptive populations where reproductive behavior is not affected by the number of children already born.

NET MIGRATION The difference between gross immigration and gross emigration.

NET REPRODUCTION RATE The average number of female children born per woman in a cohort subject to a given set of age-specific fertility rates, a given set of age-specific mortality rates, and a given sex ratio at birth. This rate measures replacement fertility under given conditions of fertility and mortality: it is the ratio of daughters to mothers assuming continuation of the specified conditions of fertility and mortality.

OWN-CHILDREN METHOD A refinement of the reverse-survival procedure for fertility estimation, whereby estimates of age-specific fertility rates for the recent past are obtained by relating mothers to their own children, using information on relationship and other characteristics available from a census or survey.

PARITY See children ever born.

PARTIAL BIRTH RATE The proportion of the population that enters (that is, is "born" into) a given age category in a year. The age categories used are normally open-ended, thus the partial birth rate x+ designates the proportion of the population becoming x years and older.

PARTIAL DEATH RATE The proportion of the population that leaves (that is, "dies" out of) a given age category in a year. See partial birth rate.

PERIOD FERTILITY The fertility experienced during a particular period of time by women from all relevant birth or marriage cohorts; see also cohort fertility.

P/F RATIO METHOD A consistency check for survey information on fertility. Information on recent fertility is cumulated to obtain measures that are equivalent to average parities. Lifetime fertility in the form of reported average parities by age group (P) can then be compared for consistency with the parity-equivalents (F) by calculating the ratio P/F for successive age groups. If certain assumptions about error patterns are met, an improved estimate of fertility can sometimes be obtained by correcting the age pattern of current fertility to agree with the level of lifetime fertility reported by younger women.

POPULATION CHANGE DUE TO MIGRATION The sum of in-migrants minus out-migrants during a specified period of time. The change may also be expressed as a rate by dividing the change by person-years-lived in the population during the same period.

PREGNANCY HISTORY A report of the number and the dates of occurrence of all the pregnancies experienced by a particular woman. The outcome of the pregnancy--live birth, stillbirth, fetal death--is also recorded.

RADIX The hypothetical birth cohort of a life table. Common values are 1, 1,000, and 100,000.

RATE OF NATURAL INCREASE The difference between the births and deaths occurring during a given period divided by the number of person-years-lived by the population during the same period. This rate, which specifically excludes changes resulting from migration, is the difference between the crude birth rate and the crude death rate.

RETROSPECTIVE SURVEY A survey that obtains information about demographic events that occurred in a given past period, generally terminating at the time of the survey.

REVERSE PROJECTION See reverse survival.

REVERSE SURVIVAL A technique to estimate an earlier population from an observed population, allowing for those members of the population who would have died according to observed or assumed mortality conditions. It is used as a method of estimating fertility by calculating from the observed number of survivors of a given age x the expected number of births that occurred x years earlier. (In situations for which both fertility and mortality are known or can be reliably estimated, reverse survival can be used to estimate migration.)

ROBUSTNESS A characteristic of estimates that are not greatly affected by deviations from the assumptions on which the estimation procedure is based.

SEX RATIO AT BIRTH The number of male births for each female birth, or male births per 100 female births.

SINGULATE MEAN AGE AT MARRIAGE (SMAM) A measure of the mean age at first marriage, derived from a set of proportions of people single at different ages or in different age groups, usually calculated separately for males and females.

STABLE POPULATION A population exposed for a long time to constant fertility and mortality rates, and closed to migration, establishes a fixed age distribution and constant growth rate characteristic of the vital rates. Such a population, with a constant age structure and constant rate of growth, is called a stable population.

STATIONARY POPULATION A stable population that has a zero growth rate, with constant numbers of births and deaths per year. Its age structure is determined by the mortality rates and is equivalent to the person-years-lived (${}_nL_x$) column of a conventional life table.

SURVIVAL RATIO The probability of surviving between one age and another; often computed for age groups, in which case the ratios correspond to those of the person-years-lived function, ${}_nL_x$, of a life table. Also called survivorship probabilities.

SURVIVORSHIP PROBABILITIES See survival ratio.

SYNTHETIC PARITY The average parity calculated for a hypothetical cohort exposed indefinitely to a set of period age-specific fertility rates.

TOTAL FERTILITY RATE (TFR) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given set of age-specific fertility rates; also referred to as total fertility. It is frequently used to compute the consequence of childbearing at the rates currently observed.

UNITED NATIONS AGE-SEX ACCURACY INDEX An index of age reporting accuracy that is based on deviations from the expected regularity of population size and sex ratio, age group by age group. The index is calculated as the sum of (1) the mean absolute deviation from 100 of the age ratios for males, (2) the mean absolute deviation from 100 of the age ratios for females, and (3) three times the mean of the absolute difference in reported sex ratios from one age group to the next. The United Nations defines age-sex data as "accurate," "inaccurate," or "highly inaccurate" depending on whether the index is less than 20, 20 to 40, or greater than 40.

WHIPPLE'S INDEX A measure of the quality of age reporting based on the extent of preference for a particular target digit or digits. The index essentially compares the reported population at ages ending in the target digit or digits with the population expected on the assumption that population is a linear function of age. For a particular age range, often 23 to 62, the population with ages ending in the target digits is divided by one-tenth of the total population, the result then being multiplied by 100 and divided by the number of different target digits. A value of 100 indicates no preference for those digits, whereas values over 100 indicate positive preference for them.

References

Abadan, Nermin (1964) *Batı Almanya'daki Türk Iscileri ve Sorunları* (Turkish Workers in West Germany and Their Problems). Ankara: State Planning Organization.

Adlakha, Arjun L. (1970) A Study of Infant Mortality in Turkey. Sociology dissertation. University of Michigan, University Microfilms 71-4553.

Bongaarts, John (1978) A framework for analyzing the proximate determinants of fertility. *Population and Development Review* 4(1):105-132.

Brass, William (1968) Methods of analysis and estimation. Pp. 88-150 in W. Brass et al., ed., *The Demography of Tropical Africa*. Princeton, N.J.: Princeton University Press.

Coale, Ansley J. (1971) Age patterns of marriage. *Population Studies* 25(2):193-214.

Coale, Ansley J., and P. Demeny (1966) *Regional Model Life Tables and Stable Populations*. Princeton, N.J.: Princeton University Press.

Coale, Ansley J., Allan G. Hill, and T. James Trussell (1975) A new method of estimating standard fertility measures from incomplete data. *Population Index* 41:182-210.

Coale, Ansley J., and T. James Trussell (1974) Model fertility schedules: variations in the structure of childbearing in human populations. *Population Index* 40(2):185-258.

Das Gupta, Prithwis (1975) A general method of correction for age misreporting in census populations. *Demography* 12(2):303-312.

Demeny, Paul, and Frederic C. Shorter (1968) *Estimating Turkish Mortality, Fertility, and Age Structure: Application of Some New Techniques*. Faculty of Economics, Istanbul University, Pat. No. 1306.

Fisek, Nusret H. (1978) Türkiye'de Asırı Dogurganlık ve Kullanilan Gebeligi Önleyici Yöntemler (Excess Fertility and Contraceptive Methods in Turkey). In S. Uner, et al. *Türkeiyede Nüfus Yapısı ve Nüfus Sorunlar: 1973 Arastırması* (Population Structure and Population Problems in Turkey: 1973 Survey). Hacettepe University, Publication No. D-25.

Geray, Cevat (1962) *Türkiye'den ve Türkiye'ye Göcler ve Göcmelerin Iskanı 1923-1961* (Migration from and to Turkey and the Settlement of Immigrants). Turk Iktisadi Gelismesi Arastirma Projesi, No. 9, Ankara.

Hacettepe Institute of Population Studies (1980) *Turkish Fertility Survey, 1978*. First Report, Vol. II: Statistical Tables. Hacettepe University.

Hajnal, John (1953) Age at marriage and proportions marrying. *Population Studies* 7:111-132.

Institute of Community Medicine (1975) *An Account of the Activities of the Etimesgut Rural Health Disrict, 1970-1974*. Hacettepe University, School of Medicine.

Macura, Miroslav (1975a) Estimates of Infant Mortality Trends in Turkey, 1944-67. Paper presented to the Second Conference on Turkish Demography, Hacettepe Institute of Population Studies, Cesme, Turkey.

Macura, Miroslav (1975b) Estimating Trends of Infant Mortality from Pregnancy Histories. *Seminar on Infant Mortality in Relation to the Level of Fertility*. (Bangkok, May 6-12, 1975.) Paris: Committee for International Coordination of National Research in Demography.

Ntozi, James Patrick Manyenye (1978) The Demeny-Shorter and three-census methods for correcting age data. *Demography* 15(4):509-521.

Özbay, Ferhunde (1979) Türkiye'de 1963, 1968 ve 1973 Yıllarında Aile Planlamasi Uygulamalarında ve Dogurganlıktakı Degismeler (Changes in Contraceptive Use and Fertility in Turkey 1963, 1968 and 1973). *Istatistik* 1(2):31-47. Istatiskciler Dernegi, Ankara.

Özbay, Ferhunde (1978) Education and fertility in rural Turkey. *Studies in Development* 22/23. Journal of Middle East Technical University, Ankara.

Özbay, Ferhunde, and Frederic C. Shorter (1970) Turkey: changes in birth control practices, 1963 to 1968. *Studies in Family Planning* 51:1-7.

Özbay, Ferhunde, Frederic C. Shorter, and S. Yener (1977) Accounting for the Trend of Fertility in Turkey. Paper presented to UN/UNFPA Expert Group Meeting on Demographic Transition and Socioeconomic Development, Istanbul.

Shorter, Frederic C. (1980) Computational Methods for Regional Population Projections and Reverse Projections. *Regional Papers*. Population Council, Cairo.

Shorter, Frederic C., and David Pasta (1974) *Computational Methods for Population Projections with Particular Reference to Development Planning*. The Population Council, New York.

Sullivan, Jeremiah (1972) Models for the estimation of the probability of dying between birth and exact ages of early childhood. *Population Studies* 26(1):79-97.

Sümbüloglu, Kadir (1978) Il ve Ilce Merkezlerinden Devlet Istatistik Enstitüsüne Bildirilen Ölümler Sayisal Yönden Yeterli: Midir?" (Are the Numbers of Deaths Reported From Province and District Centers to the State Institute of Statistics Numerically Complete?). Faculty of Medicine, Hacettepe University.

Taeuber, Irene (1958) Population and modernization in Turkey. *Population Index* 24(2):101-122.

Tekce, Belgin (1974) Urbanization and Migration in Turkey. Sociology dissertation. Princeton University, University Microfilms 76-269.

Tekce, Belgin (1975) *Migration to Cities in Turkey: Estimates for 1955-60 and 1960-65*. Ankara: State Institute of Statistics.

Tekce, Belgin (1979) The Yozgat (Turkey) Maternal and Child Health and Family Planning Project: Baseline Information on Socioeconomic and Demographic Conditions. *Regional Papers*. Population Council, Cairo.

Timur, Serim, et al. (1971) *Türkiyede Aile Yapısı ve Nüfus Sorunları Arastırmasının Veri Toplam Teknikleri (1968)* (Methodology of Survey on Family Structure and Population Problems in Turkey). Hacettepe University, Publication No. D-9.

Timur, Serim (1974) Fertility. In Figen Karadayi, et al., *The Population of Turkey*. World Population Year Series. Hacettepe University and CICRED: Institute of Population Studies.

Toros, Aykut (1978) 1973 Arastırmasında Dogurganlık (Fertility in the 1973 Survey). In S. Uner et al. *Türkeiyede Nüfus Yapısı ve Nüfus Sorunlar: 1973 Arastırması* (Population Strucutre and Population Problems in Turkey: 1973 Survey). Hacettepe University, Publication No. D-25.

Trussell, T. James (1975) A re-estimation of the multiplying factors for the Brass technique for determining childhood survivorship rates. *Population Studies* 29(1):97-108.

Turkay, Orhan (1962) *Türkiye'de Nüfus Artısı ve Iktısadı Gelisme* (Population Growth and Economic Development in Turkey). Ankara.

Turkey, Ministry of Health and Social Welfare (1973) *Saglik Hizmetlerinde 50 Yil* (50 Years in Health Services). Ankara: Ministry of Health and Welfare Publications.

Turkey, Regional Planning Office (1968) *Il ve Ilcelerin Nüfus Düzeltmeleri: 1935-1965* (Adjustments of Province and District Population: 1935-1965). Ankara: Ministry of Housing and Resettlement.

Turkey, School of Public Health (1970) *Vital Statistics from the Turkish Demographic Survey: 1966-67*. Ankara: Ministry of Health and Social Welfare.

Turkey, State Institute of Statistics (1971) *Türkiye Hayat Tablolari, 1966-67* (Life Tables of Turkey, 1966-67). Publication No. 623, Ankara.

Turkey, State Institute of Statistics (1978) *Türkiye Nüfus Arastırması: 1974-75* (Turkish Population Survey: 1974-75). Publication No. 841, Ankara.

U. N. (1967) *Manual IV: Methods of Estimating Basic Demographic Measures from Incomplete Data*. Department of Economic and Social Affairs, Population Studies, No. 42.

Yener, Samira (Berksan) (1969) Marriage patterns and their effect on fertility in Turkey. In *Turkish Demography: Proceedings of a Conference*. Hacettepe University: Institute of Population Studies.